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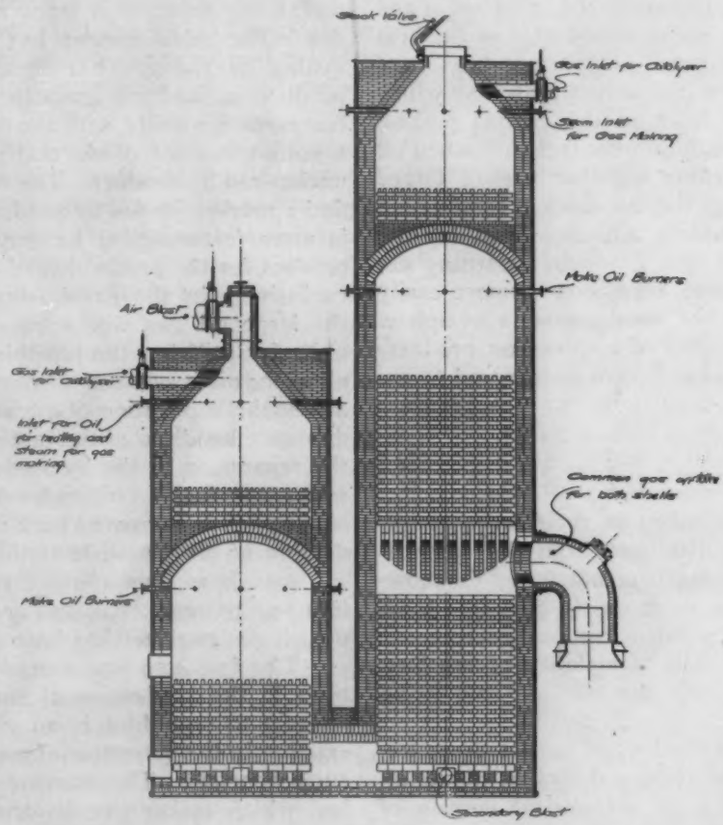
MANUFACTURE OF OIL GAS[1]

BY L. B. JONES.

It is not my intention to attempt to cover the scope suggested by the title of this paper, but merely to review a series of experiments and the resultant developments, carried on in San Francisco in the past few years.

Since 1902 when gas made exclusively from crude oil was first introduced as the supply of a large city until today when oil gas is used to the exclusion of all other methods of production in California, many have doubted the eventual success of this process. But the doubters were not in the ranks of the true oil gas men, the noble pioneers who conceived the idea of the manufacture of gas from crude oil years before the enormous production of crude oil in California made oil gas an economic necessity and those who nursed the infant industry and bravely bore the discouragement of failures and put on a solid running basis, an industry which in the hands of less noble men might easily have been a failure from its inception.

For years the one feature which has prevented oil gas from being an ideal process for gas manufacture has been the large percentage of the rich hydrocarbons of the oil which are dissociated, only the hydrogen portion of which appears in the gas, the carbon being a by-product. The severe treatment of the oil with extremely high heats was the cause of the excessive production of lampblack in the early oil gas and the proportionately poor quality of the gas.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It was not alone the extreme temperature but the lack of uniformity of temperature. The extremely high temperature being in a measure what we might call "false heat" or "surface heat"; that is, the actual temperature existed but its capacity for doing work in the breaking up of the oil was lacking. The extreme temperatures lasted only during the beginning of a run or gas-making period and in the latter part of a run, the temperatures were far below any now utilized for gas making. Were this not so, the efficiency of the early oil gas would have been extremely high, only the quality of the gas being low. Had uniformly high heats been employed, the early oil gas man would have encountered no scrubbing troubles other than the removal of lampblack. Tar would have been an unknown trouble. But this we know was not the case.

The oil used per thousand feet was high, the

[1]Paper presented at Twenty-first Annual Convention Pacific Coast Gas Association.

quality of the gas was low and tar as well as lampblack represented a large portion of the oil. In each run, a portion of the oil was destroyed by being subjected to temperature far in excess of the bonding point of its hydro-carbons and the remainder was stewed at temperatures below the fixing point of a commercial gas.

It was soon realized that during the run at some intermediate point between the extremes of temperature, the oil was subjected to the proper degree of heat—a treatment that produced not only a good quality of gas but efficient results. But this point was quickly reached and more quickly passed and the results attained were lost in the aggregate. By a process of elimination, we may assume that if one temperature is right for the reforming of the oil, all the rest must be wrong. And from this theory, the striving has been toward the maintaining of a uniform temperature, the treatment of all the oil alike. The greatest mechanical development tending to unify the heat to which the oil is subjected was the improvement of the two shell machine with the gas offtake intermediate of the point of combustion of the oil used for heating the generator and the stack valve. It has been definitely proven not only by experience but by careful tests that the heat of the checker brick or heat reservoirs immediately adjacent to the stack valve and also the point where the initial combustion of the heat oil takes place is "false heat" or "surface heat" and lacks the body and is not the substantial heat which we find in the checker brick in the central portion of the generator. This is due to the fact that when oil is injected into the machine together with a forced blast of air for heating the apparatus, combustion is not immediately complete but the heat of the checker brick is utilized in a gradually lessening degree to convert the oil into a gaseous or more easily combustible state until the combustion is complete. The following three samples of combustion products will show more clearly what I have endeavored to explain:

	CO_2	O_2	N_2
Sample No. 1	14.2	0.0	85.8
Sample No. 2	15.0	0.0	85.0
Sample No. 3	15.4	0.0	84.6

These samples were taken in their order simultaneously at increasing distances from the combustion chamber, the increasing percentage of CO_2 showing the combustion to be more nearly complete some distance from the initial point of combustion.

The reason for the lack of stability of the heat in the checker brick nearest the stack is usually an economic one.

In order to minimize the loss of heat at the stack, the combustion should be regulated so that the maximum liberation of heat is in the central portion of the checker work and the checker work nearest the stack gets only the tail end of the combustion and while the brick attain a considerable temperature, they do not contain any great quantity of heat.

A result of these peculiar combustion conditions is the inverse variation of the temperatures in the two ends of a generator; if the combustion end is excessively hot, the stack end will be proportionately cool. From this fact, the two shell machine with the gas offtake intermediate of the course of combustion in heating, derives its undisputed advantage over all other forms of generators, the natural balance of heat in the two shells maintaining a uniform quality and production of gas at all times.

In the two shell sets where oil is injected with steam into the top chamber of both the long and short shell simultaneously for gas making and the gas offtake is located in the lower half of the long shell, the first temperature to which the oil is subjected is not the maximum temperature. The checker brick in the upper portion of each shell with which the oil first comes in contact do the greatest amount of work and are the regulators which limit the quantity of oil per run, but the temperature of these brick does not constitute the fixing or superheating temperature to which the gas is subjected in the central portion of the long shell near the offtake. While the temperature in the upper portion of the checker brick in each shell to which the oil and steam are first subjected vary several hundred degrees Fahrenheit during a run, the superheating or fixing temperature remains fairly constant.

In the past ten years, the art of manufacturing gas from crude oil has advanced rapidly until today, the modern oil gas is without doubt, the most nearly ideal fuel, being superior in many respects to coal or water gas. The advancement has been not alone in the quality of the gas but equally in the efficiency of production, and oil gas, the infant industry, now compares favorably with the older methods as regards a comparison of production, raw material used and unchanged by-product. The coal gas man is forced to find a market for his by-product while the oil gas man is more fortunate, as he may utilize the carbon by-product for the production of water gas and thus stay exclusively in the gas business. For several years, the large oil gas works have maintained water gas units for utilizing the lampblack and thus practically all of the oil is eventually converted into gas. But this meant the duplication of a great deal of apparatus and duplicate handling of the raw material first as oil, then the separation of the by-product and the handling as water gas fuel. This extra labor is excessively expensive when compared with the ideal oil gas, the production of oil gas without the lampblack by-product.

And it is thus along these lines, the combining into one process what was accomplished in two, that the oil gas engineer has been working.

The first step was a study of the existing conditions in the production of lampblack water gas. To attempt to reproduce in an oil gas set the conditions existing in the generator of a water gas set was apparently hopeless. The extreme temperature of the fuel bed which makes the dissociation of steam and the conversion of most of the carbon to carbon monoxide possible would be disastrous to the hydro-carbons of the oil and as a luminous high heat value gas is still the requirement, the attempt to imitate the generator portion of the apparatus was given up. While the apparatus used in the production of water gas from lampblack is substantially the same as employed when coal is used as the base, certain differences exist in operating conditions. The best results are obtained

with an empty carburetor using no checker work. The temperatures employed are higher and the time of contact proportionately less than when using coal. The same quality of oil is used for enriching in the water gas as is used in the production of oil gas. The carburetor and superheater temperatures are nearly as great as are employed in oil gas and yet no lampblack is produced. Wherein lies the difference? It is a well known fact that certain chemical reactions are entirely different when taking place in an atmosphere of air or in an atmosphere of hydrogen. Certain reactions will only take place or are greatly stimulated by the presence of a catalyser. This catalyser does not enter into the reaction, yet its presence is essential.

The one great difference between conditions in an oil gas set and the conditions in the carburetor of a water gas set is the atmosphere into which the oil is injected.

When the heating period is completed in an oil gas set, the interstices of the brick and the chambers are filled with carbonic acid and nitrogen, the products of combustion from the heat oil and into this inert atmosphere the oil for gas-making is injected. In the water gas carburetor, it is entirely different, the oil is injected into an active atmosphere of carbon monoxide and hydrogen produced in the generator and passing through the carburetor. And this gas is the catalyser which prevents the destruction of the oil and the consequent waste of large quantities of uncombined carbon.

Here was a condition which could be reproduced in the oil gas generators. It was at first thought to attach a small water gas generator to one of the large oil gas sets. This was not practical as our endeavors were to eliminate the lampblack by-product and this would have been our only available solid fuel for the water gas generator.

We next endeavored to produce the desired result by purging one of the 16 ft. Jones sets with steam for a minute before any oil was injected. This was done by admitting all available steam after the blast valve and stack valve were closed and the machine ready to make gas. A portion of this steam was dissociated and recombined with the fine particles of carbon remaining on the brick from the previous heating period, thus forming an active initial atmosphere.

The two following analysis sheets show the results of this test. Gas samples were taken from the primary and secondary shells just above and below the common gas offtake at the end of each consecutive minute. The temperature quantity and quality of oil and all other conditions were as nearly identical as possible in these two runs except that all available steam was turned into the set for one minute previous to the admission of any oil in Run No. 2. A comparison of the two runs shows a marked increase in the quality of the gas in the second run, especially in the first few minutes. The marsh gas and illuminants were greatly increased especially in the primary, and the carbon monoxide of the primary gas was considerably increased. These conditions were not due to any reduction in temperature as the quantity of gas made in the second run was greater than in the first and in both runs, identically the same quantity of oil was used.

Run No. 1.

The following table shows the composition of oil gas made in the primary and secondary shells of generator 3 at the same time. The samples are taken at the end of each consecutive minute for a complete run of 10 minutes at an outlet of the primary just below the offtake and at the secondary just above it:

Minutes.		CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2
1.	Pri.	6.2	.6	6.0	15.4	27.9	17.9	26.0
	Sec.	9.8	4.2	.4	12.8	26.7	35.2	10.9
2.	Pri.	3.4	.6	.8	15.6	54.9	23.9	.8
	Sec.	5.4	5.4	.4	9.6	39.6	36.8	2.8
3.	Pri.	2.6	1.2	.6	14.6	48.6	27.0	5.4
	Sec.	4.0	6.0	.6	8.2	33.0	43.3	4.9
4.	Pri.	2.2	1.2	.6	14.6	48.9	28.1	4.4
	Sec.	3.2	6.8	Tr.	7.4	39.5	41.3	1.8
5.	Pri.	2.2	2.0	.2	13.8	50.9	28.6	2.3
	Sec.	2.6	6.8	.2	7.4	37.8	41.5	3.7
6.	Pri.	2.0	2.0	.4	13.4	49.3	28.8	4.1
	Sec.	2.2	8.0	.4	6.0	38.9	41.7	2.8
7.	Pri.	2.0	2.0	.6	13.6	51.4	28.8	2.8
	Sec.	2.0	7.8	.2	6.6	38.9	41.7	2.8
8.	Pri.	4.6	1.0	.2	16.2	62.4	13.0	2.6
	Sec.	2.2	8.0	1.0	6.0	42.3	38.6	1.9
9.	Pri.	7.2	.4	.2	14.6	68.1	6.4	3.1
	Sec.	3.8	6.8	.6	8.2	47.6	30.2	2.8
10.	Pri.	7.6	1.2	.2	12.6	74.1	4.0	.3
	Sec.	5.4	5.6	.2	10.4	52.3	22.2	3.9

Run No. 2.

The following table shows the composition of oil gas made in the primary and secondary at the same time. The samples were taken at the end of each consecutive minute for a run of 11 minutes at the outlet of the primary below the offtake and at the secondary above the offtake. During the first minute of the run no oil was used, but all the available steam was turned on in both shells:

Minutes.		CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2
2.	Pri.	7.0	1.4	.6	18.2	40.8	31.5	.5
	Sec.	3.0	4.6	.8	7.2	39.4	40.8	4.2
3.	Pri.	4.2	2.4	.4	15.8	41.2	32.2	3.8
	Sec.	2.8	6.0	.4	6.2	41.7	41.3	2.4
4.	Pri.	2.8	3.0	.4	13.8	45.3	33.3	1.4
	Sec.	2.2	6.0	.4	6.0	44.6	39.8	1.0
5.	Pri.	2.4	3.4	.2	13.0	45.9	32.4	2.7
	Sec.	1.8	7.0	.4	5.6	44.0	40.4	.8
6.	Pri.	2.4	3.2	.4	11.6	42.1	37.1	3.2
	Sec.	1.6	7.4	.4	5.4	43.5	41.1	.6
7.	Pri.	1.6	3.0	1.0	10.2	46.8	36.4	1.0
	Sec.	1.0	10.0	.6	4.4	37.2	43.4	3.4
8.	Pri.	2.2	3.2	.6	10.2	38.2	40.5	5.1
	Sec.	1.0	8.8	.8	4.0	45.9	36.6	2.9
9.	Pri.	1.6	2.6	1.0	10.4	47.8	33.8	2.8
	Sec.	5.4	2.4	.8	12.2	70.4	7.9	.9
10.	Pri.	3.6	2.6	.8	14.0	50.9	22.4	5.7
	Sec.	8.0	2.4	.6	13.4	63.8	7.6	4.2
11.	Pri.	5.2	1.2	.8	15.4	60.2	14.2	3.0
	Sec.	9.0	1.4	1.0	12.2	66.2	6.4	3.8

The initial atmosphere produced by the dissociation of the steam in the first minute benefited materially the gas produced in the first few minutes of the run. To produce the desired results, it is not sufficient to commence the destructive distillation of the oil in an initial atmosphere of an active gas or gases but to continue in an atmosphere other than the gas produced by the machine from minute to minute. Natural gas under pressure would be ideal for the production of this catalytic atmosphere but as no natural gas is available at the present time in San Francisco, our own oil gas scrubbed, purified and ready for distribution proved the best substitute. And it is this gas that is used today in the improved oil gas process. The idea of putting a finished saleable gas from the storage holders back into the generators may seem queer to say the least, but I will endeavor to prove that it is not queer but quite the proper thing to do.

At this stage of our experiments, the Metropolitan Company was acquired. The major portion of

their generating equipment consisted of two oil gas units. These were two shell sets, both shells 15 ft. in diameter by 39 ft. high connected at the bottom by a large rectangular throat piece. Each shell was equipped with a stack valve and gas offtake at the top and heat burners at the bottom. The oil for gas making was injected at the top of one shell passing downward through the neck and up the second shell. Each alternate run, the direction was reversed. The small capacity of these sets in comparison to their size made a reconstruction necessary. The rebricking and re-arrangement of these sets was an ideal opportunity partially to test the ideas of the new process.

In our estimation, the apparatus for the best results from this new process would be a two shell set, a long and a short shell connected at the bottom by an ample throat piece, the top of the short shell being the blast inlet and the top of the long shell the stack valve, the common gas offtake located on the side of the long shell intermediate of its ends. The bricking and checker work to be so arranged as to form double chambers in the upper end of each shell. Short piers in the bottom of each shell support the main checker work up about two-thirds of the height of the short shell and three-fourths the height of the long shell. At this point, open arches are sprung across the shell forming the tops of the lower chambers and supporting the upper sets of checker work. About twelve courses of checker work rest on each of these arches and the top of this checker and the corbel work forms the top chamber of each shell.

Into the top chamber of the primary or short shell extend the oil burners for heating the apparatus connected to coils of pipe circling the shell. In the same manner, the injectors for admitting oil for gas making are connected into the lower primary chamber and the lower secondary chamber. To the top chambers of each shell are connected gas lines for the admission of gas under pressure for producing the catalytic atmosphere. This supply is regulated by valves controlled from the operating floor. Into these top chambers also are steam connections for supplying steam for gas making and also for purging. After the machine is properly heated and ready for a gas making period, the stack valve and blast valve are closed and the gas and steam under pressure are admitted into the top chambers of each shell.

The illustration on the first page more clearly shows the idea.

During the first minute, no oil is admitted and all the products of combustion from the previous heating period are purged from the machine. Thus at the end of the first minute when oil is admitted into the lower chambers of each shell, it comes in contact with an active atmosphere of gas and steam highly superheated by passing through the upper section of checker brick. The decomposition or destructive distillation of the oil therefore begins and is continued in an active atmosphere and when the excess carbon is freed from the reforming of the hydro-carbons, it is surrounded by steam in a highly superheated condition ideal for dissociation and combination with this carbon. It has long been the practice to admit the oil and steam for gas making together.

This practice to a large degree accounts for the variable temperatures to which the oil is subjected during the run. While the heat absorbed by the steam actually converted into gas is proportionately small, the heat absorbed by the total steam used including the steam used to purge the machine after the run, is a large factor in the total heat absorption. In a thousand cubic feet of average oil gas, the steam actually converted in its production based on the oxygen content seldom exceeds 6 lbs., while the actual steam used for injecting the oil is seldom less than 16 lbs., and the steam used to purge the machine in the last three minutes increases this amount to nearly 27 lbs. per M. cubic feet. These figures are based on actual running conditions, tests showing that during a ten minute run in which 2300 lbs. of oil was injected in the first seven minutes of the run and the production was 40,000 cu. ft., the steam meter showed a consumption of 5700 lbs. per hour, or 665 lbs. of steam during the run and the steam used during the purge to be 8000 lbs. per hour or 400 lbs. during the purge. The heat, therefore, absorbed by the steam during the first seven minutes was 14 per cent of the total heat absorbed and during the entire run including the purge, the steam is accountable for 19 per cent of the total heat loss or reduction in temparature. (These figures based on a specific heat of .6 for oil .305 for steam). It is not the loss of this heat from the standpoint of monetary value of the added heat oil to regain this loss of temperature which constitutes the error of this practice but it is not giving the oil a square deal. The oil is continually being subjected to a decreasing temperature and as the duration of the run must be sufficient to keep up the capacity and efficiency of the machine, the initial temperature must be above or the final temperature below that temperature which will produce both quality in gas and efficiency in results. The top chambers in the apparatus of the new process eliminate this fault to a great extent, the heat of the lower chambers being used exclusively for the breaking up of the oil while the steam and gas are superheated to the temperature of the apparatus by the brick in the upper portion of the machine before entering the gas making chambers. Thus where the reformation of the hydro-carbons leaves an excess of carbon in a free state, steam in a highly superheated condition is immediately present for combination. To entirely exclude steam except under a high degree of superheat from the gas making chambers, gas under high pressure is utilized for injecting the make oil. In some works where high pressure gas is not available, the cost of compression for this use alone might prove excessive. In that case, the steam on the injectors may be reduced to a minimum, the major portion being admitted in the upper chambers.

The addition of the top chambers and checker brick above the gas making chambers is a marked improvement in itself. Besides superheating the steam and gas, these chambers are the means of obtaining a uniform substantial heat in the lower portion of each

shell as any sharp surface heat due to combustion effects the upper sections of brick which are not utilized for the distillation of the oil.

Another material benefit is the use of large chambers between the top of the checker work and the oil injectors thus permitting the oil to be partially broken up or at least vaporized by radiated heat before coming in direct contact with the brick. This is not only a benefit to the oil and brick but permits the heat of a greater number of the brick to be utilized before the temperature of the top portion of brick is reduced below a gas making temperature. The practice of the early oil gas man of attempting to fill all the space within his machine with checker brick accounts for considerable of the carbon accumulation which caused frequent shut downs and many hours of blasting to burn out. This was caused by injecting the oil directly onto the top courses of the checker brick. These brick soon lost the greater portion of their heat and only the lighter portion of the oil was vaporized, the heavier portion accumulating as solid masses of carbon. Another factor greatly affecting not only the condition of the machine but the efficiency of the results and quality of the gas are the injectors or means of introducing the oil into the generators. This subject was the basis of a series of recent experiments, and various types and means of admitting oil were thoroughly tested. Many styles of vaporizers or injectors have been used with varying degrees of success but in every case, the vaporizer is located just inside the coil and vaporized oil and steam are conveyed to the machine through pieces of pipe extending through the lining. The result of these tests showed that the greatest fault was not the vaporizer proper but the means of conveying or the treatment after vaporization.

After testing many various types of vaporizers, it was found that most of them gave an almost perfect oil fog at the tip or outlet when the steam pressure was maintained about 5 lbs. more than the oil pressure.

When sections of ¾ in. pipe such as are used to convey the oil through the lining were screwed onto these burners, a large portion of this oil fog was condensed. Various sizes and lengths of pipe were then tried. The length made no material difference but the only size with which efficient results were attained was found to exactly conform to the size of the end of the tip in the ejector. It also worked equally well with ¾ in. pipe or even larger if the end or tip was reduced to an orifice to conform to the area of the ejector. The best results with the ejector of the Hayden and Derby type, most commonly used was with ¾ in. pipe capped with a ¾ to ¼ in. reducer through which a ½ in. drill had been previously run to remove the threads. Apparently therefore, the one essential requirement in injecting oil is to maintain the velocity after vaporizing until the oil reaches the machine.

While the basic principals of the destructive distillation of oil and the temperature conditions existing within the machines have been the subject of first importance and greatest thought, the lesser refinements and mechanical improvements have all aided materially in obtaining better results.

In speaking of the effect of various temperatures on certain oils and the resultant gas reference is only made to the quality of the heat. The quantity of heat or time to which the oil or gas is subjected to any temperature is a factor which has been entirely overlooked in oil gas practice. The quantity of heat or time of contact is of as great importance as the temperature or quality, for upon the one depends the effectiveness of the other. Many conditions affect the time of contact factor, the area and length of the machine, the number and arrangement of the checker brick and the rate of production of the generator. These factors constitute the velocity of the gas. Widely different results may be obtained when the same temperature is utilized for oil gas making and the velocity or time of contact varies. Likewise similar results may be obtained when the temperature varies within certain ranges and the velocity is increased or decreased to suit. To produce similar results, an increase in temperature requires an increase in velocity or decrease in time of contact. The temperature to a certain extent influences the velocity and to this reason may be attributed the fact that its importance was not sooner realized. If a machine is excessively hot, a larger quantity of gas is produced, the velocity is increased, and therefore it is subjected to the heat for a shorter period of time. The expansion of the gas due to temperature also tends to maintain a balance between the temperature and velocity, but as there is no proportionate relation between temperature and time of contact, both factors must be considered.

In order to demonstrate the effect of velocity or time of contact on the gas, five runs were made on the No. 4 set at the Metropolitan Works. At the time this set was rebuilt, it was deemed advisable to more fully test the new method before making any radical changes. As the two shells of this set were of the same length, only the primary shell was equipped with the upper chamber and double set of checker brick with the idea of adding the upper chamber to the secondary at some future time, should the tests be successful. This set is only mechanically complete in one shell, in all other respects it is all that could be desired for testing the ideas of this new method. In the five runs referred to, it was endeavored to maintain all conditions other than the time of contact or velocity the same. This was accomplished by increasing the duration of each run. The first run was of ten minutes' duration; the second, eleven; the third, twelve; the fourth, thirteen; and the fifth, fourteen minutes. In each run, the first minute was devoted to purging with gas and the last three minutes to purging with steam. Thus only the time required to introduce the oil was increased and in each run practically the same amount of oil was used.

At the end of each minute, gas samples were taken at the wash box, temperature and oil readings were taken and the gas measured in the relief holder. The purge gas used was measured by a station meter.

The following tables give the analysis and quantity of gas made in each minute of each run and all the conditions affecting the runs. The average analyses for the run are based on the analysis and make of each minute.

Average Analysis of 10, 11, 12, 13 and 14 Minute Runs, No. 4 Metropolitan Set, August 2-7, 1913. Velocity Test.

Run.	Net Make.	Total Oil per M.	CO_2	CnH_2n	O_2	CO	H_2	CH_4	N_2	B.t.u.
10 minute	36715	8.6	3.0	6.1	0.0	7.3	43.7	35.6	4.3	679
11 minute	39609	8.5	3.1	7.1	Tr.	6.2	41.2	37.4	5.0	706
12 minute	39361	8.47	3.6	6.6	0.0	5.1	39.3	38.2	7.2	695
13 minute	39158	8.53	3.1	7.6	Tr.	6.0	40.8	38.0	4.5	721
14 minute	40204	8.6	3.2	6.6	0.0	6.1	42.2	37.5	4.4	700

Run No. 1, No. 4 Jones Set, Metropolitan, 11.00 a. m., Aug. 2, 1913 (10 Minute.)

Minutes.	Gross Make.	Purge Gas.	Net Make.	Prim. Oil.	Sec. Oil.	Total Oil.	Degrees Fahrenheit. Prim. Temp.	Sec. Temp.	Neck Temp.
0.							1610	1460	1670
1.	1576	800	776				1580	1400	1670
2.	4202	800	3402	15.5	14.5	30.0	1550	1310	1680
3.	6531	700	5831	25.2	25.2	50.4	1520	1210	1670
4.	6531	700	5831	21.5	23.3	44.8	1510	1180	1670
5.	5914	800	5114	21.4	22.4	43.8	1490	1150	1670
6.	5892	800	5092	20.5	23.3	43.8	1480	1120	1660
7.	5366	800	4566	15.7	20.3	36.0	1480	1100	1660
8.	4133	200	3933	10.9	10.0	20.9	1480	1110	1660
9.	1553		1553				1480	1130	1650
10.	617		617				1480	1160	1650
	42315	5600	36715	130.7	139.0	269.7			

Make Oil.....269.7 =7.34 Gals. per M.
Heat Oil..... 46.7 =1.26 Gals. per M.

Total Oil.....316.4 Gals. =8.60 Gals. per M.

Net Gas Made.36715 Cu. ft.

Analysis Sheet, Run No. 1, No. 4 Jones Set, Metropolitan, 11 a.m. Aug. 2, 1913. (10 Minute.)

Minutes.	Net Make	CO_2	CnH_2n.	O_2	CO	H_2	CH_4	N_2	Sp. Gr.	B.t.u.
1.	776	23.2	.3	0.0	9.5	5.2	18.4	43.4	.975	258
2.	3402	3.3	4.9	0.0	8.4	43.1	36.1	4.2	.451	665
3.	5831	1.8	5.5	0.0	6.7	44.4	38.0	3.6	.422	694
4.	5831	1.5	6.1	0.0	6.0	43.2	39.6	3.6	.425	717
5.	5114	1.4	7.0	0.0	5.6	42.1	40.1	3.8	.432	734
6.	5092	1.2	7.8	0.0	4.9	41.6	40.9	3.5	.433	755
7.	4566	1.3	8.1	0.0	4.8	40.5	41.5	3.8	.441	762
8.	3933	4.1	5.8	0.0	11.3	50.4	25.6	2.8	.433	603
9.	1553	11.0	2.0	0.0	17.0	61.1	8.2	0.7	.428	396
10.	617	13.0	1.6	0.0	16.9	59.4	6.9	2.2	.478	369
Total.	36715									
Av. analysis.		3.0	6.1	0.0	7.3	43.7	35.6	4.3	.444	679

Run No. 2, No. 4 Jones Set, Metropolitan, 11:20 a. m., Aug. 2, 1913, (11 Minute.)

Minutes.	Gross Make.	Purge Gas.	Net Make.	Prim. Oil.	Sec. Oil.	Total Oil.	Degrees Fahrenheit. Prim. Temp.	Sec. Temp.	Neck Temp.
1.							1580	1370	1680
1.	1419	800	619				1590	1370	1680
2.	2580	800	1780	19.6	21.5	41.1	1560	1320	1670
3.	5640	700	4940	16.8	23.3	40.1	1550	1210	1670
4.	6280	700	5580	20.5	24.3	44.8	1530	1150	1670
5.	6028	800	5228	19.6	19.6	39.2	1500	1120	1670
6.	5572	700	4872	15.8	22.4	38.2	1500	1100	1660
7.	5317	700	4617	19.6	24.2	43.8	1490	1080	1660
8.	5707	800	4907	18.6	24.2	42.8	1480	1060	1650
9.	4561	300	4261				1480	1060	1650
10.	2024		2024				1480	1080	1650
11.	781		781				1480	1100	1650
	45909	6300	39609	130.5	159.5	290.0			

Make Oil.....290.0 =7.3 Gals. per M.
Heat Oil..... 46.7 =1.2 Gals. per M.

Total Oil.....336.9 Gals. =8.50 Gals. per M.

Net Gas Made..39609 Cu. ft.

Analysis Sheet, Run No. 2, No 4Jones Set, Metropolitan 11:20 a.m., Aug. 2, 1913, (11 Minute.)

Minutes.	Net Make	CO_2	CnH_2n.	O_2	CO	H,	CH_4	N_2	Sp. Gr.	B.t.u.
1.	619	20.3	0.0	1.0	5.7	No expl'sn.		73.0	1.082	20
2.	1780	9.0	3.0	0.0	15.0	45.0	24.3	3.7	.514	526
3.	4940	3.0	6.0	0.0	7.0	41.1	37.8	5.1	.459	691
4.	5580	2.0	7.0	0.0	5.0	42.1	40.1	3.8	.434	732
5.	5228	1.5	7.0	0.0	5.5	41.1	40.9	4.0	.438	739
6.	4872	1.7	7.6	0.0	4.7	41.1	40.9	4.0	.439	748
7.	4617	1.7	9.1	0.0	4.2	38.7	42.5	3.8	.453	785
8.	4907	1.7	9.3	0.0	4.0	38.3	43.2	3.5	.453	795
9.	4261	2.0	9.0	0.0	5.0	42.9	37.8	3.3	.437	750
10.	2024	8.2	3.8	0.0	14.0	51.8	18.5	3.7	.472	501
11.	781	12.8	1.6	0.0	15.7	57.5	9.3	3.1	.485	384
Total.	39609									
Av. analysis		3.1	7.1	Tr.	6.2	41.2	37.4	5.0	.460	706

The increase in time of contact by the increase in duration of the run from ten to eleven minutes shows a marked increase in the quality of the gas.

The illuminants were increased 1 per cent, the methane 1.8 per cent, the hydrogen was decreased and the heating value increased by 27 B.t.u's. The increase from six to seven minutes (in which time the oil was injected), would constitute an increase in time of contact of 16 per cent, but as 8 per cent more gas was made in the eleven minute run, the actual increase amounts to only 8 per cent.

Run No. 3, No. 4 Jones Set, Metropolitan, 11:40 a.m., Aug. 2, 1913. (12 Minute.)

Minutes.	Gross Make.	Purge Gas.	Net Make.	Prim. Oil.	Sec. Oil.	Total Oil.	Degrees Fahrenheit. Prim. Temp.	Sec. Temp.	Neck Temp.
0.							1620	1390	1680
1.	1244	600	644				1590	1350	1680
2.	1561	700	861	16.8	19.4	36.2	1570	1300	1680
3.	4878	700	4178	14.0	18.7	32.7	1560	1190	1670
4.	5463	700	4763	19.6	18.6	38.2	1550	1130	1670
5.	5512	700	4812	17.7	18.6	36.3	1530	1100	1670
6.	4976	700	4276	14.0	19.6	33.6	1520	1080	1660
7.	4927	700	4227	14.0	19.6	33.6	1520	1050	1660
8.	4951	700	4251	16.8	21.4	38.2	1510	1040	1650
9.	5098	700	4398	17.7	21.4	39.1	1500	1020	1650
10.	4146		4146				1510	1020	1650
11.	1927		1927				1510	1040	1640
12.	878		878				1500	1080	1640
	45561	6200	39361	130.6	157.3	287.9			

Make Oil.....287.9 =7.30 Gals. per M.
Heat Oil..... 45.8 =1.17 Gals. per M.

Total Oil.....333.7 Gals. =8.47 Gals. per M.

Net Gas Made..39361 Cu. ft.

Analysis Sheet, No. 4, Jones Set, Metropolitan, Aug. 2, 1913. (12 Minute.)

Minutes.	CO_2	CnH_2n	O_2	CO	H_2	CH_4	N_2	Sp. Gr.	B.t.u.
1.	16.0	0.0	0.0	0.0	Gas would not explode,		84.0	1.059	000
2.	20.0	1.0	0.0	12.0	22.7	23.5	20.8	.780	380
3.	6.4	4.0	0.0	10.6	37.3	34.9	6.8	.525	618
4.	4.0	5.0	0.0	7.4	41.8	36.2	5.6	.535	657
5.	1.7	6.4	0.0	4.5	42.8	40.1	4.5	.428	721
6.	1.7	7.3	0.0	4.4	40.4	40.4	5.8	.447	733
7.	2.0	7.8	0.0	4.2	39.6	41.6	4.8	.452	752
8.	1.8	8.4	0.0	2.8	37.2	43.5	6.3	.464	772
9.	1.6	8.6	0.0	2.8	37.7	43.5	5.8	.459	778
10.	1.6	8.9	0.0	2.2	39.7	42.9	4.7	.443	782
11.	6.0	5.7	0.0	9.7	46.7	26.2	5.7	.474	589
12.	10.8	2.6	0.0	13.6	54.3	13.4	5.3	.496	451
Average.	3.6	6.6	0.0	5.1	39.3	38.2	7.2	.477	695

Run No. 4, No 4 Jones Set, Metropolitan, 11:20 a.m., Aug. 7, 1913. (13 Minute.)

Minutes.	Gross Make.	Purge Gas.	Net Make.	Prim. Oil.	Sec. Oil.	Total Oil.	Degrees Fahrenheit. Prim. Temp.	Sec. Temp.	Neck Temp.
0.							1670	1610	1680
1.	1370	700	670				1640	1600	1680
2.	2215	800	1415			11.2	1620	1590	1680
3.	3906	800	3106	11.4	13.9	25.3	1610	1580	1670
4.	4453	800	3653	13.5	16.4	29.9	1600	1590	1670
5.	4864	800	4064	15.2	18.4	33.6	1590	1590	1670
6.	5343	700	4643	17.2	21.0	38.2	1550	1600	1670
7.	5846	800	5046	19.4	23.5	42.9	1520	1600	1670
8.	5206	700	4506	18.0	21.9	39.9	1500	1600	1670
9.	5024	800	4224	16.9	20.4	37.3	1500	1600	1670
10.	4156	800	3356	13.6	16.6	30.2	1490	1600	1660
11.	3151	800	2351				1500	1560	1660
12.	1530		1530				1510	1530	1660
13.	594		594				1510	1520	1650
	47658	8500	39158	130.5	158.0	288.5			

Make Oil.....288.5 =7.37 Gals. per M.
Heat Oil..... 45.8 =1.16 Gals. per M.

Total Oil.....334.3 Gals. =8.53 Gals per M.

Net Gas Made..39158 Cu. ft.

Analysis Sheet, No. 4 Jones Set, Metropolitan, 11:20 a.m., Aug. 7, 1913. (13 Minute.)

Minutes.	Net Make	CO_2	CnH_2n.	O_2	CO	H,	CH_4	N_2	Sp. Gr.	B.t.u.
1.	670	22.2	0.4	0.6	8.8	9.8	17.0	41.2	.852	87
2.	1415	7.5	4.1	0.0	11.4	39.3	32.1	5.6	.525	601
3.	3106	4.5	4.5	0.0	9.4	43.5	33.3	4.8	.466	629
4.	3653	3.4	5.0	0.0	7.6	44.8	35.7	3.5	.438	663
5.	4064	2.4	6.6	0.0	6.0	45.3	36.8	2.9	.422	704
6.	4643	1.8	7.8	0.0	4.6	42.0	40.0	3.8	.436	747
7.	5046	1.6	8.6	0.0	3.8	41.6	41.6	2.8	.422	774
8.	4506	1.7	9.4	0.0	3.7	38.3	43.3	3.6	.455	797
9.	4224	1.9	9.7	0.0	4.0	35.2	45.0	4.2	.477	812
10.	3356	2.0	9.2	0.0	4.6	37.9	42.1	4.2	.465	781
11.	2351	3.0	7.5	0.0	7.5	39.2	36.9	5.9	.480	707
12.	1530	5.2	6.0	0.0	9.4	45.0	29.1	5.3	.473	619
13.	594	12.4	1.6	0.0	14.3	57.8	9.0	4.9	.481	337
Total.	39158									
Av. analysis.		3.1	7.6	Tr.	6.0	40.8	38.0	4.5	.462	721

Run No. 5, No. 4 Jones Set, Metropolitan, 11:40 a. m., Aug. 7, 1913. (14 Minute.)

Minutes.	Gross Make.	Purge Gas.	Net Make.	Prim. Oil.	Sec. Oil.	Total Oil.	Degrees Fahrenheit. Prim. Temp.	Sec. Temp.	Neck Temp.
0.							1700	1620	1690
1.	1233	700	533				1660	1600	1690
2.	1416	700	716	2.7	3.3	6.0	1640	1590	1690
3.	4658	600	4058	14.3	17.4	31.7	1620	1570	1680
4.	3707	700	3007	11.0	13.3	24.3	1610	1560	1680
5.	4098	700	3398	12.6	15.4	28.0	1600	1560	1680
6.	5171	700	4471	16.8	20.5	37.3	1560	1570	1680
7.	5098	700	4398	15.2	18.4	33.6	1550	1560	1670
8.	4146	600	3536	11.3	13.8	25.1	1560	1560	1670
9.	3610	700	2910	9.7	11.7	21.4	1550	1550	1670
10.	3658	700	2958	11.8	14.3	26.1	1550	1550	1670
11.	4414	700	3714	15.1	18.4	33.5	1520	1550	1670
12.	4524	700	3824	9.9	12.1	22.0	1510	1560	1660
13.	1901		1901				1520	1480	1650
14.	780		780				1520	1480	1650
	48404	8200	40204	130.5	158.5	289.0			

Make Oil.....289.0 =7.2 Gals. per M.
Heat Oil..... 45.8 =1.13 Gals. per M.

Total Oil.....334.8 Gals. =8.33 Gals. per M.

Net Gas Made..40204 Cu. ft.

Analysis Sheet, No. 4 Jones Set, Metropolitan, 11:40 a. m., Aug. 7, 1913. (14 Minute.)

Minutes.	Net Make	CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2	Sp. Gr.	B.t.u.
1.	533	22.0	0.0	0.0	7.6	9.8	15.3	45.3	.940	224
2.	716	18.8	1.0	0.0	11.2	26.5	22.4	20.1	.743	389
3.	4058	4.0	4.8	0.0	8.6	40.4	37.2	5.0	.473	663
4.	3007	3.2	5.8	0.0	7.0	44.3	36.4	3.3	.437	683
5.	3398	3.0	6.2	0.0	6.4	44.1	36.6	3.7	.438	691
6.	4471	1.6	6.4	0.0	4.4	43.3	40.9	3.4	.421	731
7.	4398	1.6	7.6	0.0	4.2	41.4	41.9	3.3	.421	759
8.	3536	2.0	8.8	9.0	4.6	41.4	40.2	3.0	.442	767
9.	2910	2.6	6.7	0.0	6.1	44.2	37.4	3.0	.431	708
10.	2958	2.2	7.3	0.0	5.1	40.8	40.6	4.0	.447	740
11.	3714	1.8	8.0	0.0	4.2	39.6	42.3	4.1	.447	764
12.	3824	1.8	8.2	0.0	3.6	39.4	42.5	4.5	.448	768
13.	1901	6.9	4.3	0.0	15.0	57.4	15.4	1.0	.427	499
14.	780	8.8	3.5	0.0	15.3	59.9	12.1	.4	.429	458
Total.	40204									
Av. analysis.		3.2	6.6	0.0	6.1	42.2	37.5	4.4	.452	700

Drop in Purge Gas in 3d minute affected 4th minute's gas.
Drop in Purge Gas in 8th minute affected 9th minute's gas.

A slight increase in methane is counteracted by a decrease in illuminants in the twelfth minute and from then, the methane decreases and the hydrogen increases with an increase in time of contact. Very little benefit is derived by the increase after eleven or possibly twelve minutes and the velocity of the gas in the eleventh minute might be considered as proper in proportion to the temperature for this machine.

The time of contact should be regulated in the construction of the generator by the length of shell or arrangement of checker work as any increase in length of run decreases the daily capacity of the machine. The practice of forcing machines to their fullest capacity is common to the oil gas man. Every machine has a capacity where efficiency and quality of gas may be combined and if the machine is forced, one or the other is sacrificed. When these tests were first undertaken with the idea of converting a greater percentage of the carbon of the oil into gas, it was the belief that this carbon would combine with the steam used and appear in the gas as carbon monoxide.

While the gas made by the new method embraces a larger part of the carbon of the oil, the carbon monoxide content is lower than in the gas made the usual way. The conditions for the production of carbon monoxide are equally as good and in fact superior. The temperature is sufficient, as a large quantity of carbon monoxide is produced in the last three minutes of the run after the oil is shut off. In fact, there is no good reason to believe that carbon monoxide is not formed. This leads to the belief that it is formed and combined after formation. We are thus forced to consider the production of methane or marsh gas synthetically.

Several years ago, such a suggestion would have been tabooed, but since the experiments of eminent chemists have proven the theory and have produced methane or marsh gas synthetically, we must seriously consider its production on a practical scale. A great many of the experiments conducted by these chemists in the production of synthetic marsh gas have been in conjunction with a study of catalysis and in this

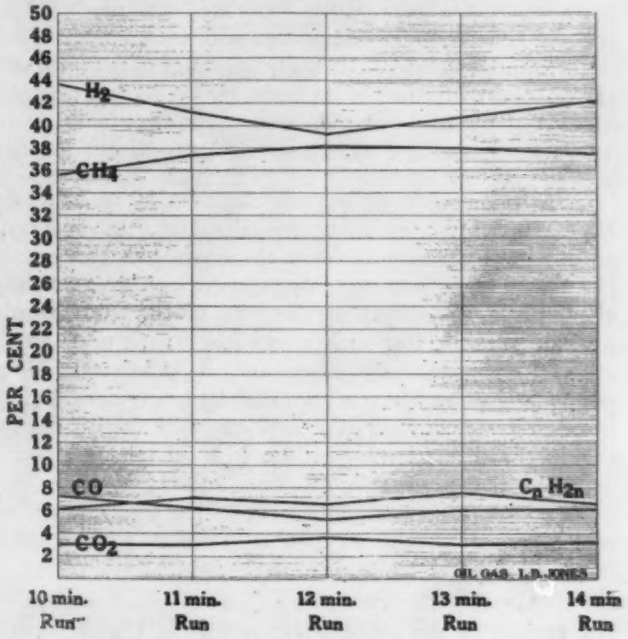


Chart Showing Effect of Velocity on Quality of Gas.

respect, our experiments of a highly practical order have paralleled those theoretical or laboratory experiments. In Bulletin 7 of the Department of the Interior, the authors quote the experiments of Mayer, Henseling and V. Altmeyer as described in the German Journal of Gas Lighting, Vol. 52

In view of the fact that at the temperature employed in the velocity tests described, the formation of carbon dioxide from steam and carbon and the reaction from carbon dioxide to carbon monoxide is very sluggish, all reasoning would lead to the conclusion that an increase in the time of contact in the runs in which the velocity was decreased would produce a greater percentage of carbon dioxide and carbon monoxide.

In all probability, this ts true, and more carbon monoxide was produced, but was utilized for the production of synthetic marsh gas. There are several equations which might be followed in the eventual conversion of carbon and steam into marsh gas, but from the ratio of the constituents of the gas, the probable equation is as follows:

$$2H_2O + C = 2H_2 + CO_2$$
$$CO_2 + C = 2CO$$
$$2CO + 4H_2 = 2CH_4 + O_2$$
$$O_2 + C = CO_2$$

It has always been the theory that marsh gas was purely the result of destructive distillation of the oil and this is undoubtedly true of the larger portion appearing in the gas, but the exceptionally large quan-

tity of marsh gas in the gas of the new process upholds the theory of its production synthetically.

From the foregoing reaction, an increase in marsh gas would be accompanied by an equal decrease in carbon monoxide and an increase of one-half as much carbon dioxide and a decrease of twice as much hydrogen. Reference to the average analyses of the runs of the velocity test shows this to be true.

A comparison of the ten-minute run with the twelve-minute run shows

Increase in marsh gas	2.6%
Decrease in carbon monoxide	2.2%
Decrease in hydrogen	4.4%
Increase in carbon dioxide	.6%

Comparing the ten with the eleven-minute run shows

Increase in marsh gas	1.8%
Decrease in carbon monoxide	1.1%
Decrease in hydrogen	2.5%
Increase in carbon dioxide	.1%

In order to prove beyond the possibility of doubt that marsh gas is being produced synthetically, it would be necessary to have the hydrogen content of the illuminants and marsh gas combined greater than the hydrogen content of the oil. Such proof would be indisputable, but such a gas has not to my knowledge been produced. However, it is reasonable to suppose that as the carbon and hydrogen are linked in the oil, the destructive distillation of the oil resulting in the liberation of carbon in a free state also results in the liberation of some hydrogen in a free state. This is undoubtedly true, as the hydrogen from steam based on the oxygen content seldom exceeds 35% of the free hydrogen of the gas.

Upon this theory that the uncombined carbon or the carbon of the oil less the carbon in the gas bears some practical relation to the free hydrogen of the gas, ten samples of gas from the old method were tested. These samples showed an average proportion of 22.5 to 1 in a comparison of weight of uncombined carbon vapor and hydrogen. In no sample did the proportion fall below 21.3 or exceed 23.3 to 1—22.5 then might be considered a fair average relation, but only on this type of machine and under the same running conditions. Undoubtedly the entire marsh gas content of the oil gas made by the old method is solely the result of the distillation of the oil. The hydrogen content therefore of the gas represents the maximum liberation of free hydrogen.

As the general running conditions of the new and old method are similar, it is permissible to apply this proportion to the new process. Let us consider the ten-minute run of the volocity test. After we make proper deductions from the total oil for .5 gallon of tar per thousand feet, we find 46.51 lbs. of carbon introduced. The gas contained 18.417 lbs. of carbon, leaving as uncombined 28.09 lbs. of carbon. Applying our proportion theory to this quantity of uncombined carbon, we find the hydrogen content of the gas derived from the oil to be 39.4%. From the oxygen content of the gas, we find the hydrogen content from steam to be 13.3%, or a total hydrogen content of 52.7%. The gas by analysis showed only 43.7% hydrogen; therefore 9% of the freed hydrogen has been recombined and appeared in the gas as marsh gas.

This same theory applied to the eleven-minute run shows 8.9% of hydrogen to have been converted into marsh gas and 11.2% in the thirteen-minute run. If we deduct the percentage of marsh gas formed synthetically and deduct equally for carbon monoxide from the analysis of the ten-minute run and add to the hydrogen and carbon dioxide in proportion to the equation of its formation, we have the following comparison:

Gas Analysis of 10 Minute Run.		Same Analysis Stripped of Synthetic Marsh Gas.
CO_2	3.0	.8
CnH_2n	6.1	5.8
O_2	0.0	0.0
CO	7.3	11.0
H_2	43.7	50.0
CH_4	35.6	29.1
N_2	4.3	3.3

The second analysis is reduced slightly in all its constituents, as the volume of the marsh gas formed was not equal to the original volume of its components. The second analysis stripped of its synthetic marsh gas

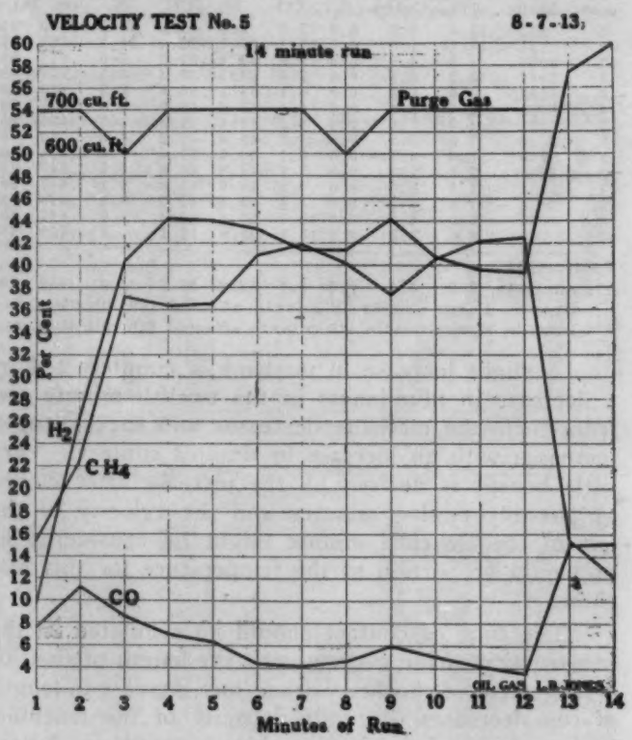


Chart Showing Relation of Purge Gas, CO, H_2 and CH_4.

is a typical analysis of the gas produced in the old process. To more clearly show the positive effect of the catalytic atmosphere on the quality of the gas and especially on the production of the marsh gas, a curve has been plotted of the constituents of the gas each minute of the fourteen-minute run. The gas used for the catalytic atmosphere dropped twice during this run from 700 to 600 cubic feet per minute. These drops in the third and eighth minute affected materially the gas produced in the following minutes.

The oil used per thousand cubic feet of gas made in the new process is not at the present time greatly less than in the old method, but the gas is far superior. The production of synthetic marsh gas in an oil gas set opens great possibilities for the future oil gas. With the eventual abolition of the candle-power standard, it marks the way to the production of a high heat

unit gas with very little candle-power at a reduced cost.

While the gas of the new process embraces 15 per cent more carbon than the gas of the old method, this amount only constitutes 5 per cent more of the total carbon used. The average carbon content in a thousand cubic feet of the old oil gas is 17 lbs. and in the gas of the new process 19½ lbs. While this is a considerable increase, there is vast room for improvement. In order to produce a gas of the quality of that made in the ten-minute run shown without any by-products of lampblack or tar and no loss of carbon at the stack, a thousand cubic feet of gas would have to be produced from 21.6 lbs. or 2.7 gallons of oil. This of course would represent 100 per cent efficiency. If the lampblack were eliminated and the loss at the stack stopped and we still produced one-half gallon of tar and the same quality of gas, a thousand cubic feet would then have to be produced from 25.7 lbs. or 3.2 gallons of oil. It appears from these figures that while great progress has been made in the efficiency of production of oil gas, we are still far from what might be considered good efficiency. As a matter of fact, in the best results yet attained, the carbon of the gas represents less than 40 per cent of the carbon of the oil. These figures are based on actual carbon used as oil and carbon in the gas and may seem low to one who is accustomed to compare the carbon in the gas with the lampblack by-product. In the new process as well as the old, the actual carbon accounted for as gas, lampblack and tar seldom exceeds 60 per cent of the carbon of the oil. The greatest loss of carbon is at the stack, of which no account is kept.

The troubles with carbon accumulating in the early oil gas generators is responsible for the practice which still prevails of blowing the machine before each heating period. After the run is taken off, all the available air at the greatest available pressure is turned into the machine for three minutes, at the end of which time the air is reduced and oil turned in for heating. During the run, there is a slight accumulation of carbon on every checker brick and during the blow the greater portion of this is wasted.

Often have we watched the sparks from our stacks at night, but few have reailzed that in those tiny sparks more fuel was being wasted than is introduced as oil in the following heating period.

In the operation of the old process in which 20 lbs. of lampblack of 55 per cent moisture or 11 lbs. of dry is recovered, and approximately 7½ gallons of oil are used, after allowing for one-third of a gallon of tar, shows a loss at the stack of 20 lbs. of carbon per thousand.

This amount in a run of 50,000 feet production amounts to 1000 lbs., or 2½ times the amount of heat oil used. This carbon in the aggregate is of considerable amount, but when divided over 30,000 checker bricks amounts to slightly over one-half ounce per brick, which represents a film of one-thousandth of an inch thick on the exposed checker brick surface.

Apparently there is no hope of preventing this loss, as it must be cleared from the machine after each run, or it would soon accumulate and form a stoppage. If this could be stopped, a gas of the same quality might be produced with the same quantity of by-product of lampblack and tar from 4.4 gallons of oil. This loss, therefore, represents the carbon content of 2.6 gallons of oil per thonsand. It seems impossible at the present time to stop the loss and thus save a large quantity of oil, but a large portion of the loss can be utilized and thus will not represent a total loss. The carbon accumulation not only amounts to over twice the amount of fuel required to heat the generator each run, but is distributed evenly throughout the checker work, and this presents an ideal fuel for the uniform heating of the checker brick. An equal amount of fuel is burned and an equal amount of heat liberated on the surface of each checker brick. In order to utilize this carbon for heating the set, after the run is taken off, a very small quantity of air is introduced into several points in the set. Besides the carbon on the brick, this method utilizes the greater portion of the gas remaining in the machine from the previous run. This amounts to over 3000 cubic feet on the large sets of a gas of over 350 B.t.u.'s, or over a million heat units, equal to nearly 7 gallons of oil. This not only utilizes a large quantity of heat which is no wlost, but eliminates the smoke nuisance of a gas works, which at the present time is attracting considerable attention.

With a few such refinements, the oil gas works of the future may be considered a desirable neighbor rather than a nuisance.

This new method of heating has only been introduced and practically demonstrated at the Metropolitan plant within the past few weeks. No radical changes were made in introducing this method, but it was endeavored rather to gradually reduce the quantity of heat oil until a point was reached where a loss in temperature or an increase in time required to heat would make further reduction false economy.

At the present time, the first five minutes of the heat are devoted to burning the gas and carbon in the machine with a very light blast and the remaining five minutes, oil is used. In this way, the heat oil has already been reduced 45 per cent, or over one-half gallon per thousand cubic feet of gas. While this and a possible greater reduction, until little or no heat is used, is of great importance, a feature of perhaps greater importance is the quality of the heat produced. Before this new method of heating was introduced and oil was used exclusively for heating, the drop in temperature of the checker brick just below the primary and secondary make chambers during a run was seldom less than 250° F. With the new method using the same quantity of oil during the run, the drop seldom exceeds 100° F. This shows that a far more substantial and uniform heat is produced.

In all of the experiments described, a distillate of about 18° B. was used and undoubtedly better results could have been obtained with crude oil.

The Metropolitan Works is not an experimental plant, but is one of the large producers for the supply of San Francisco.

While this plant produces over three million feet per day, at no time has the lampblack and tar by-product been more than sufficient for boiler fuel.

ELECTRICAL PUMPING AND IRRIGATION

THE SELECTION AND INSTALLATION OF A SMALL PUMPING PLANT.

BY B. A. ETCHEVERRY.

The proper selection of a pumping plant depends upon many factors which should be carefully considered by the intending purchasers. These factors are: (1) Source of water supply; (2) capacity of plant and period of operation; (3) the kind of pump; (4) the class of engine or driving power; (5) the first cost; (6) the fuel cost; (7) the cost of fixed charges and attendance. These factors are interdependent and should be considered together. Their relative importance will vary with local conditions and for that reason it is not possible to state definite rules which will apply in all cases. A study of the conditions affecting each factor is therefore necessary in each case.

Source of Water Supply.

The source of water supply may be surface water supply, such as water occurring in rivers, lakes, canals, etc., or may be ground water supply. Where surface water is available, the water will be developed by means of a proper intake, which for the simplest cases will consist of the suction pipe of the pump extending into the body of water. Where ground water is available the most common means of development is by wells.

Wells.

The well may be a dug, bored or drilled well. The most common form of well for individual pumping plants in California is a drilled or bored well 10 to 16 inches in diameter or larger, lined with a casing, which may be one of the three following types:

1st. Standard steel screw casing.

2nd. Single galvanized iron casing, No. 12 to 16 gauge, with joints riveted together.

3rd. Double black steel casing, No. 12 to 16 gauge, known as California stove-pipe casing, and very generally used in Southern California. This casing is made of riveted steel sections 2 ft. long placed with broken joints. The bottom of the casing consists of a starting section 15 to 20 ft. long, made of triple thickness, riveted together, and with a steel shoe at the lower end.

The well and casing should extend into the water-bearing gravel sufficiently far to give a perforated area equal to at least five times the cross section area of the well. The perforations are made with an improved cutting tool, and consist of 6 to 8 slits made in each ring or circle; each slit 12 to 18 in. long and ⅜ to ¾ in. wide. A space of 4 in. is skipped and another ring of slits staggered with the adjacent ones is made. Slits should not be over 18 in. long with stove-pipe casing.

In Southern California, near Chino, the price of drilling deep wells is as follows:

For 10, 12 and 14 inch wells in fine material, $1.25 per ft. for first 500 ft.

For 16 inch wells in fine material, $1.50 per ft. for first 500 ft.

For depths greater than 500 ft. the price is 50 cents extra on each additional foot.

The cost per foot of steel stove-pipe casing is about as follows:

Diameter.	12 Gauge.	14 Gauge
10"	$1.12	$0.92
12	1.27	.99
14	1.51	1.12
16	1.80	1.24

Capacity of Plant and Period of Operation.

The required capacity of the plant will depend on the area irrigated, the duty of water or depth of water required on the land and the period of operation. For ordinary orchard soil a total depth of 12 in. of water during the irrigation season will be sufficient for young orchards. For a full-bearing deciduous orchard 18 in., and for a citrus orchard, 24 in. should be ample, while for alfalfa and other forage crops 24 to 36 in. is plenty. Where the cost of pumping is high, such as for small plants and high lifts, it will usually not be feasible to grow at a profit anything but orchards. To reduce the cost of pumping, no excess water should be used, all losses should be prevented by careful irrigation and thorough cultivation, in which case a young orchard on fairly deep retentive soil may not require more than 6 to 9 in. of irrigation water and a full bearing orchard not more than 12 or 15 in. for deciduous trees and 18 in. for citrus trees during the irrigation season. To put a depth of 2 ft. of water on one acre, it takes a flow of very nearly 1 cu. ft. per second for 24 hours; this is equivalent to 450 U. S. gallons per minute for 24 hours. This relation can be applied to any case to obtain the size of the pump. For example, if it is desired to irrigate a 40-acre orchard 1½ ft. deep, in an irrigation season of 120 days, this requires 60 acre feet in 120 days or ½ of an acre foot per day. This will be obtained by a pump giving ¼ of a cu. ft. per second, or 110 U. S. gallons per minute, when the pump is operated continuously 24 hours a day every day during the irrigation season of four months. For a 10-acre orchard the required capacity based on the same conditions would be ¼ of the above, or 28 gallons per minute, or 1/16 of a cu. ft. per second.

The above two examples are based on a pump operating continuously at the rates given above. While continuous operation decreases the required size of plant, it is usually preferable to select a plant of larger capacity and operate it only a part of the time. This is especially desirable for very small orchards, in which case continuous operation gives a stream too small to irrigate with. The other disadvantages of continuous operation are:

1st. Continuous operation requires continuous irrigation and constant attention to operate the pumping plant. For very small tracts a regulating reservoir may be used, but it must be of considerable capacity to be of any service, and it must be lined with concrete to prevent seepage losses of the water, which when pumped is too valuable to lose. Usually it is

preferable to purchase a larger plant and do without a reservoir.

2d. Continuous operation gives a small stream which cannot be applied economically.

3d. Continuous operation means that the water cannot be applied to the different parts of the orchard within a short time, so that only a small part of the orchard or farm receives the water when most needed, and the remainder must be irrigated either too early or too late.

4th. A small plant is less efficient and requires a proportionately larger fuel consumption than a larger plant to pump the same quantity of water.

On the other hand a very short period of operation requires a comparatively large pumping plant, which will greatly increase the first cost of installation, the interest on the capital invested, the depreciation and fund necessary to provide for renewal. It also requires a larger source of supply, which may not always be available. For instance the required flow may exceed the capacity of the well or may so lower the water plane that the cost of pumping will be increased. Also in some localities the power company may offer a low flat rate for continuous use.

Usually it is desirable to operate the pump not over 1/2 or 1/3 of the time during the irrigation season and often a shorter period is desirable. This requires a pumping plant two or three times or more the size required for continuous irrigation. The capacity of the pump must be sufficient in all cases to give a large enough stream to irrigate economically; even for the smallest orchards a stream of at least 5 to 10 miners' inches or about 50 to 100 U. S. gallons per minute, is desirable.

For a full bearing orchard 18 in. of irrigation water for deciduous trees and 24 in. for citrus trees, applied in three to four irrigations of 6 in. each, at intervals of 30 to 40 days, should be ample in most cases. As stated above, where the water has to be pumped to high elevation, the higher cost of the water demands great care in its use and 12 to 18 inches total depth of irrigation water would be sufficient.

The table below gives the required pump capacity for various sizes of orchards or farms and for different

Necessary capacity of pumps in U. S. gallons per minute to give a 6 inch depth of water on the land each month when operated the following number of of 24 hour days each month.

Area, acres.	30 days.	20 days.	15 days.	10 days.	5 days.	2.5 days.	1 day.
5	19	28	38	56	113	225	563
10	37.5	56.25	75	112.5	225	450	1125
15	57	85	113	170	340	675	1690
20	75	113	150	225	450	900	2250
30	113	169	225	338	675	1350	3375
40	150	225	300	450	900	1800	4500
60	226	338	450	675	1350	2700	6750
80	300	450	600	900	1800	3600	9000
120	450	675	900	1350	2700	5400	13500

periods of operation. It is based on a depth of irrigation water of 6 in. each month, or 18 in. in 3 months, which is taken as the irrigation season. The period of operation is given in number of 24 hour days that the pumping plant is operated each month. These days need not be consecutive; for instance if the operation period is 10 days, instead of applying 6 in. of water in one irrigation lasting 10 days, the soil may be so porous and gravelly that it will not retain moisture, in which case it may be preferable to apply 3 in. at a time in two irrigations during the month, of 5 days each. The required pump capacity is given in U. S. gallons per minute.

The capacity of pumps for smaller or greater depths of water applied per month can be easily computed by proportion from the values given. For different areas and different periods of operation the capacity may be obtained by interpolation.

Kind of Pump.

The kinds of pump commonly used to raise water for irrigation are (1) centrifugal pumps, (2) power plunger pumps, (3) deep well pumps, (4) air lift pumps (5) hydraulic rams. Where the source of water supply is a surface body of water, either a centrifugal pump, a power plunger pump or a hydraulic ram will be used; where the source of water supply is ground water developed by wells, usually either a centrifugal pump, a deep well pump, or an air lift pump will be used and in some cases a power plunger pump. For deep wells usually the vertical centrifugal pump placed in a pit or an air lift pump is used. Hydraulic rams are used for small quantities of water such as for domestic purposes or for irrigation of small pieces of land. They are economical in operation, but reuire special conditions such as a nearby stream or canal with sufficient fall in a short distance.

A centrifugal pump consists of a circular casing with the inlet or suction end connected to the center and the outlet or discharge end formed tangent to the perimeter. Inside the casing is the runner or impeller keyed on the shaft and revolving it. It is formed of curved vanes closely fitting the casing. There are two general types: 1st, the horizontal centrifugal pump, which has a horizontal shaft; 2d, the vertical centrifugal pump with a vertical shaft. When in operation the impeller by revolving imparts a velocity to the water between the vanes and forces it away from the center of the casing towards the perimeter or rim of the casing through the outlet and up the discharge pipe. This produces a partial vacuum at the center of the impeller, which induces a flow through the suction pipe into the casing. The number of revolutions of the runner or speed of the pump has an exact relation to the head or lift against which the pump is working and for every head there is a speed for which the pump works most efficiently. This speed can be obtained from the pump manufacturers. It is important that the pump be connected to an engine or motor which will give it the proper speed. Overspeeding is preferable to under-speeding, but either reduces the pump efficiency.

Simple centrifugal pumps specially designed and driven at a sufficiently high rate of speed may be used for lifts considerably over 100 ft., but usually the stock pump obtainable from the manufacturers is not suitable for lifts over 75 ft., and for the smaller sizes the total life should not exceed 50 ft. For higher lifts compound or multi-stage centrifugal pumps are used. These consist of two or more pumps connected in series, the discharge of the first pump or stage is delivered into the suction of the next pump and the operation is repeated, according to the number of stages. Usually 75 ft. to 125 ft. is allowed to each stage. When the required capacity of the pump is over 100 or 150 gallons per minute and the total lift less than

75 ft. the centrifugal pump is no doubt the best adapted.

Centrifugal pumps are usually denoted by a number which represents the diameter of the discharge in inches. The efficient capacity of each size will vary to some extent with the speed of the pump, which depends on the total lift pumped against. The pumps can, therefore, not be rated accurately. The capacities given in the accompanying table are worked out from the ratings given by a reliable pump manufacturer, and are subject to considerable variations either above or below the values given.

Number of pump or diameter of discharge in inches	Capacity in U. S. gallons per minute	Capacity in second feet, or acre inch per hour	Number of acres irrigated 6 inches deep each month for operation period during the month of						
			30 days.	20 days.	15 days.	10 days.	5 days.	2½ days.	1 day.
2	100	.22	27	18	13	9	4½	2¼	9/10
2½	150	.33	40	27	20	13	6½	3¼	1 3/10
3	225	.50	60	40	30	20	10	5	2
3½	300	.66	80	53	40	27	13	6½	2 2/3
4	400	.90	110	71	55	26	18	9	3 2/3
5	700	1.60	190	127	95	63	32	16	6 1/3
6	900	2.00	240	160	120	80	40	20	8
7	1200	2.70	320	213	160	107	54	27	10 2/3
8	1600	3.50	430	287	215	143	72	37	14 1/3

To start a centrifugal pump the suction pipe and the pump must be filled with water or primed. This may be done by closing the discharge pipe with a check valve and connecting the suction end of a hand pump to the top of the casing. Where a steam engine is used, a steam ejector may take the place of the hand pump. For small pumps and low lifts a foot valve on the end of the suction pipe may be used and the pump primed by pouring water in the casing or suction pipe. The disadvantage of a foot valve is that if the water is not clear a small stone or twig may lodge itself in the foot valve and prevent priming. This will necessitate that the suction pipe be uncoupled and the obstruction removed.

The pump must be placed as near as possible to the water level to keep the suction lift down. While theoretically the suction lift may be as great as 33 ft. at sea level and about 30 ft. at an elevation of 3000 ft., it is desirable not to exceed 20 ft. and less is preferable. The horizontal centrifugal pumps is preferable where the depth from the ground surface to the water plans is not large. But where the depth is large, it is necessary to place the pump in a ddep pit, in which case either the vertical centrifugal pump or a deep well pump is generally used. A horizontal shaft centrifugal pump is usually more efficient than a vertical centrifugal, and it eliminates the end thrust of the shaft obtained with the vertical shaft which is difficult to balance properly. During the past few years a new type of vertical centrifugal, commonly named turbine centrifugal pump, has been developed for pumping from deep wells without the necessity of a pit. These pumps are installed inside the casing of bored wells 12 to 30 in. in diameter.

The plant efficiency can be increased by reducing the friction in the suction and discharge. As few bends as possible should be used and those should be made by using long turn elbows. The suction and discharge pipes should be larger than the intake and outlet openings of the pumps and joined to the pump with an increaser. The diameter of the suction pipe and especially of the discharge pipe should be 1½ times the diameter of the intake, and if the discharge pipe is long it may be economy to make the diameter even larger. Where the source of water supply is a surface body of water, enlarging the lower end of the suction pipe will further decrease the friction. This may be done by a funnel-shaped section whose length is about three times the diameter of the suction pipe and whose large end is about 1½ times the diameter of the pipe. The larger opening at the entrance to the suction pipe will decrease the tendency to suck up sand or gravel. When the water carries weeds, gravel, or other material a strainer should be used and the total area of the strainer should be at least twice the area of the suction pipe. The discharge pipe should not carry the water any higher than necessary.

Power piston or plunger pumps are used where the water is obtained from a surface source or where the water plane is near the surface of the ground and the lift to the point of delivery is large. It consists of one or more cylinders, in each one of which a piston or plunger moving backwards and forwards sucks the water into the cylinder and forces it up the discharge pipe. When the cylinder has only one suction valve and one discharge valve, the motion of the piston in one direction causes suction and the displacement in the opposite direction forces the water through the discharge pipe. With two sets of valves so arranged that there is a discharge for each displacement of the piston, the pump is known as a double acting pump. When the pump has two cylinders, it is known as a duplex pump, with three cylinders it is a triplex pump, and in either case may be either double acting or single acting. The cylinders with the driving gears or pulley are assembled together and built at a height above the water plane, which must not exceed the suction lift.

[To be continued.]

EXAMINATION FOR ASSISTANT IN LABORATORY PHYSICS.

The United States Civil Service Commission announces an open competitive examination for laboratory assistant in physics, for men only, on October 8, 1913, to fill vacancies as they may occur in the Bureau of Standards, at salaries ranging from $900 to $1200 per annum. Persons who desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any local office.

The new quarters of the Weber Club in the Kiesel Building, Ogden, Utah, now in course of erection, will be equipped with every modern electric convenience, including an electric churn which will produce fresh butter daily for the exclusive use of club patrons and an electric press for the manufacture of fresh cider from luscious Utah apples. All cooling will be done by a modern refrigerating plant, contract for which has been placed.

INDUSTRIAL APPLICATION OF ELECTRIC HEATING.[1]

BY W. H. LINES.

The use of electric energy for producing heat in industrial processes presents the same relative advantages over the combustion of fuel as does the electric tric drive over the older methods of transmitting energy. Cleanliness, safety, flexibility, efficiency, increased production, improvement of working conditions, and a better product, are as apparent here as in other older applications of electric energy. The growth in the use of electric energy in this field has been enormous in the past five years, far outstripping the increase in the use of electric energy for lighting and power purposes. The field of application is almost unlimited, and we find that new industries have been created by the aid of electric heat in processes only possible by this method.

General View of Electric Smelting Plant at Heroult, Cal. Incline Tramway in Left Background, Smelter Building in Center Foreground, Lime Kilns at the Right.

To accomplish a change from electric to heat energy, three different processes are open to commercial usages:

(1) The Joulean effect.

(2) The electric arc.

(3) The electrolytic effect.

The Joulean effect depends for its operation on the resistance of an electric circuit. The temperatures to be obtained are only limited by the limiting temperature of the resistance material. Temperatures as high as 5500 degrees, Fahrenheit, have been successfully obtained.

The electric arc produces the highest artificial temperature known, 6500 degrees, Fahrenheit, being the limit at which the carbon electrodes melt. Even higher temperatures may be reached as our knowledge of heat-resisting elements becomes wider.

In the electrolytic effect, electric energy is changed partly into chemical energy required for the process in the cells and partly into heat energy. The resultant heat energy gives the desired temperature.

The Joulean effect is the most commonly used of these three methods of energy transfer, and it finds application in hundreds of uses in domestic and industrial fields. The heating and cooking devices used for domestic purposes employ this effect, but they are so well known and their value as revenue producers to the central station so well appreciated that no mention will be made of them in this paper.

There is scarcely a single process in the industrial world requiring heat for its proper execution which cannot be done better, and in most cases cheaper, by the use of electricity than by the combustion of coal, gases or oil. For the purpose of this discussion I will divide the industrial application of electric heating into three general classes:

(1) Those arts and industries requiring heat energy in relatively small amounts for the completion of the process.

(2) Industries requiring heat energy in large amounts and usually at high temperatures.

(3) The use of electric energy for building heating.

In the first class there is an almost unlimited field for the successful application of electric heating. There are but comparatively few industries which do not require heat energy for at least one step in the process. In order to give some idea of the scope of this work and the great opportunity looming before the energetic new business manager, I will cite a few of these processes to which electric energy can and has been successfully applied.

In the metal trades: For melting small amounts of metal, for welding metals both by arc and spot processes, for tempering steel by the fused bath and oil tempering processes, for soldering, for enameling and japanning in ovens. In the printing and publishing trades: For heating stamping and embossing heads, matrix dryers, glue cookers, pots, etc. In the shoe and leather trades: For finishing and ornamenting leather, for treeing and ironing and for supplying small amounts of steam from an electric boiler to stitching machines. In woodworking: For glue pots and tools for producing designs. In the textile trades: For finishing rolls for silk mills, for embossing rolls for designs, for drying twine and thread and for forming hats. In laundries: For ironing and for heating sleeve, neckband, collar edging and shaping machines. In the paper industry: For heating finishing rolls for high-grade paper, for waterproofing paper and for heating automatic paper box machinery. In confectioneries and bakeries: For chocolate warmers, bake ovens, etc. In garages: For heating vulcanizing moulds. In hospitals: For sterilizing instru-

[1] A paper read at the Sixth Annual Convention of the Northwest Electric Light and Power Association.

ments and for heating various appliances for surgeons, etc.

Electrical devices, in order to accomplish the results desired, have been developed and used successfully in all the lines above enumerated, to the complete satisfaction of the user and to the material profit of the central station.

In the use of electric energy to furnish heat in large quantities for the proper completion of various industrial processes, the writer firmly believes, lies the solution of one of the most vital problems now before the central station companies of the northwest, to find a market for the sale of large blocks of surplus energy resulting from the over-development of our water powers or for the disposal of inherent electric energy now going to waste over undeveloped water power sites.

Most of the central stations of the northwest are in a peculiar position at the present time. We find ourselves in possession of surplus water power, either developed or under development, and no commercial market for its ready disposal. Usually this over-development was made in anticipation of a growth in population and industry, which has not materialized or was brought about by a forced development to hold water power sites in order that they would not revert to the state or nation. Again, the fact that this energy cannot be sold in the ordinary commercial markets is no reflection on the ability or aggressiveness of our various new business departments. An analysis of our connected load and gross earnings per capita shows that we are far ahead of the eastern companies and are securing more than our share of the available business. The field has been worked intensively, and the opportunity to sell more power is lacking. We must look to some other than the local markets to dispose of this surplus energy.

In addition to the surplus energy resulting from the over-development, we have immense amounts of power going to waste over undeveloped water power sites. We of the western states are in a far different postion than our eastern brethren. We have opportunity for the development and sale of large blocks of power at a figure undreamed of in communities where steam generation reigns supreme. In the States of Washington, Oregon and California alone there is economically capable of development over 23,000,000 h.p., or over 45 per cent of all the available water power in the country. This water power represents a natural resource, the inherent value of which is stupendous, but before any real value can accrue to it a market for its sale must be found. The entire demand for power for industrial purposes in the United States today does not exceed 30,000,000 h.p.; so it can be readily seen that it will be a matter of generations before all of this potential power will become ready for economic development.

On account of lack of density in population we cannot hope to build up large industries which will serve our own territory exclusively for some time. We cannot hope to build up industries which can sell their product in the East in competition with the eastern manufacturer on account of prohibitive transportation charges, except in those few cases where the accessibility of raw material dictates loaction on the coast. We must confine our efforts in securing those classes of business in which the element of the cost of power is the vital consideration and where the finished product is not so bulky as to make transportation charges excessive.

There is a certain class of industries coming within the scope of the above requirements, and I firmly believe that here on the Pacific Coast we have excellent opportunity to promote such industries and thus create a market for our water power. I refer to those industries requiring the use of electric furnaces of proper design for their successful operation. Among the more prominent of these might be mentioned:

(1) The reduction of iron ore and the manufacture of pig iron.

(2) The refining of steel.

(3) The manufacture of aluminum, carborundum, artificial graphite, emery, calcium carbide, iron and aluminum alloys, phosphorus and various nitrates.

It is beyond the scope of this discussion to go into a detailed description of the above processes, but I would like to call attention to the fact that the use of electric energy is of vital importance to their successful application and that the load demanded by the various processes is an ideal one for central stations to handle. The load is continuous and the load factor all that can be desired. Arrangements can easily be made to operate off the system peak, thus demanding little or no additional generating capacity over that already provided to take care of the system demand. Low rates must be offered before any of these propositions can be made attractive, but here is a justification, if anywhere, for an extremely low rate.

The Manufacture of Pig Iron.

During the past few years there has been developed and put into commrecial operation in Europe several types of electric furnaces for the reduction of iron ores. After years of experiment and partial failure, several processes were perfected and the commercial results fully justify the faith of the early promoters in this line. In America, several furnaces patterned after those in Europe have been built and proven eminently successful. The electric smelting of ore, however, is limited strictly to certain conditions in order to make it compete successfully in the market with pig, made in the ordinary blast furnace. Under a condition where rich beds of ore are located adjacent to or near water power sites and limestone, where the cost of coke is relatively high and freight rates on competing pig iron also high, this method of reduction can compete successfully. It is surprising in how many cases we find just such circumstances. Here on the Pacific Coast, conditions such as these obtain frequently. California has at least two electric furnaces for the reduction of ore in successful operation and I see no reason why there is not an opportunity for some such development in the Northwest. It is true that our ore deposits are rather limited and usually of a poor grade, but we can bring ore in by water at a low figure. Carbon of some form is necessary for the proper chemical reaction in making iron, and charcoal can be used for the purpose and give a much more

satisfactory product than the coke generally employed in blast furnace operation. It should be noted that in the electric furnace, only about one-third of the coke used in the ordinary blast furnace is required.

The two most common types of electric furnaces are the Heroult and the Girod, both being of the electrode type. There is another furnace known as the induction type, but experience so far dictates the use of the electrode type. In both the two types (the Heroult and the Girod) the heat is developed from a combination of the arc and the resistance of the charge, the difference between the two types being in the fact that in the Heroult furnace, the arc is formed between the electrodes at the top of the furnace and the charge for the other electrode, while in the Girod type, the bottom electrodes are formed of iron, water-cooled.

Three-Phase Electric Furnace Specially Designed by the Noble Steel Co. at Heroult, Cal. This Differs Inherently from the Heroult and Girod Types

Electric Steel.

By far a wider field of application of the electric furnace can be found in the making of steel from iron, particularly the higher grades of product, such as tool, projectile and automobile steel. Electro steel has many advantages over that made by the Bessemer, open hearth and crucible processes. There is an entire absence of gases, such as hydrogen and oxygen, in the finished product; no flaws or blowholes. It has a higher elastic limit, forges better, withstands higher temperatures and the process enables the manufacture of special alloys, not possible by other methods.

The electric furnace is essentially a "closed" open hearth furnace, as the process is carried on in a closed retort, thus eliminating any oxygen or free air, while in the Bessemer process the blast which accompanies the heat brings in oxygen, as does the flame in the open hearth process. Undoubtedly the absence of oxygen in the electric furnace is responsible for the smaller percentage of sulphur, phosphorus, oxide and suspended slag, thus giving a much higher grade of product. Electric steel is in great demand in the country today and commands a higher price than crucible steel, and this in face of the fact that it can be produced cheaper than in the crucible process. The cost of power is the determining factor in the refining of steel electrically, and here on the Coast we have an unusual opportunity for its successful application.

Carborundum.

Carborundum is a material obtained from the fusion of carbon and silicon in an electric furnace at a temperature of approximately 6000° F. The furnace is lined with firebrick and several carbon terminal rods, to which cables for carrying electric energy are fastened, are brought in at the top. Sand and coke or charcoal are placed in the furnace around a core of ground coke. The core completes the circuit between the terminals and offers a path of high resistance, thus producing a very high temperature. The resulting carborundum is crystalline in structure and from this is made many commercial products. It is an ideal abrasive and is used extensively in grinding tools. It is extremely refractory, withstands high temperature and hence is useful in lining furnaces where high temperatures are developed. It is a powerful deoxidizing agent and is used very extensively in the refining of steel. It has a high thermal conductivity and finds extensive application in moulds for alloys, extracting heat very rapidly.

Calcium Carbide.

Calcium carbide is formed in an electric furnace by the fusion of limestone and some form of carbon, such as coke or charcoal, at a temperature of from 5400° to 5700° F. It is an extremely valuable product and is used extensively in lighting systems and in the manufacture of nitrates for fertilizers.

Fixation of Atmospheric Nitrogen.

There are two processes for the production of various nitrates from the air:

(1) The direct separation of oxygen and hydrogen in the air is effected by the air being brought to a high temperature over a large and extenuated electric arc. The free hydrogen is then combined with other elements to form a stable compound for commercial use such as the various nitrates used for fertilizers.

(2) The nitrogen in air is combined with calcium carbide in an electric furnace to form cyanamide.

Nearly all of the above processes are capable of successful development and operation in the Northwest provided electric energy is available at a figure low enough to make them commerially feasible. In Europe the average rates paid for electric power in

large blocks for these purposes vary from $7.00 to $15.00 per kw.-year. Electric energy can be sold here at rates even higher than these and products obtained which will compete successfully on the Pacific Coast with equivalent products in the East and in Europe. If we are alive to our opportunities we will do all we can to encourage and foster the development of industries such as these on the Pacific Coast, and thus find a market for our vast water powers. If we do not seize this opportunity other agencies will. During the last session of the Oregon Legislature a bill was put through appropriating $15,000 for surveys and preliminary plans for a state development of water power aggregating 100,000 h.p. with the idea of disposing of this power to private concerns, manufacturing the various products which I have very briefly described.

ELECTRICAL GOLFERS AT GEARHEART.

The irregular quarterly convention of the Pacific Coast Electrical Supply Golfers Association was held at Gearhart, September 18-20, 1913. For the benefits of those not natives of the "webfoot state" it may be necessary to say that at the extreme western edge of Oregon, the wettest dry state in the union, is a beautiful hotel facing the six thousand miles of the tossing waves of the Pacific to the west.

The clans foregathered from north, east and south on Thursday morning when they took their special car from Portland. About a score of Californians had journeyed together from San Francisco without appearing any the worse of wear, though Sanderson did strenuous duty as nurse for Burger. As many more from other points of the compass, including a golf-delayed party from the Buffalo convention, added to

Electrical Jobbers and Manufacturers Leaving Portland for Gearheart.

Electric Building Heating.

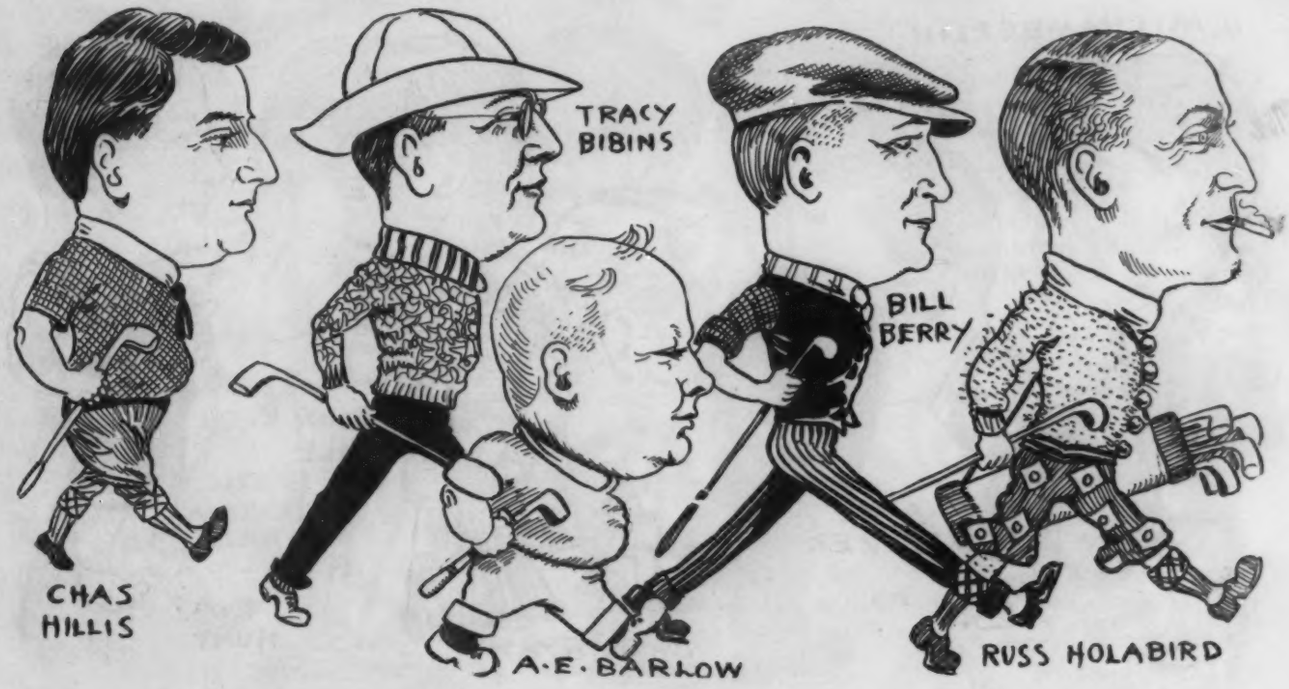
I cannot see how the heating of buildings electrically will ever work out as a commercial proposition in competition with the direct combustion of fuels, except in those few isolated cases where fuel is high, cheap water power available, close temperature regulation required and the area to be heated relatively small.

This is often impracticable and not at all an attractive business for a central station to handle. It has been argued that if a company has surplus power available, it can well afford to sell it at a flat rate per month or per year for building heating, even if the resultant rate per kw.-yr. is very low, but to my mind, this would establish a very dangerous precedent. If we could afford to sell energy for building heating at such low rates, why should we not offer the same rates to other industries using the energy under substantially the same conditions of demand and load factor? The heating business offers the further objectionable feature of being a winter or peak load business and hence less desirable than the ordinary commercial power load.

the confusion of the baggage man. Indeed Ed. Rockafellow managed to maintain his reputation as a good loser, not only of sleep and baggage, but also of golf. Fred Skeel has yet to make reckoning with a certain estimable lady who did not see Lake Louise because of his procrastination.

A convention is a fine place to meet men in an unconventional manner. Witness the clam digging and sea-dipping episodes which occupied the attention of those fortunate enough to escape Thursday afternoon's meeting! Our artist has caught some of the episodes of the trip in a manner more flattering than realistic, but an elastic imagination can supply the deficiencies.

It goes without saying that golf was the all-absorbing avocation. The perpetual handicap committee, however, gave Brainard a big job when they fixed it up for him to fill the four cups which he won, the Patton, Everready, Jobbers and Hotel Gearhart. The Portland Jobbers sprung a surprise in the form of the smallest cup on record awarded the largest gross score, handily won in a long walk by F. H. Murray, with a score of 197. All precedent was reversed by



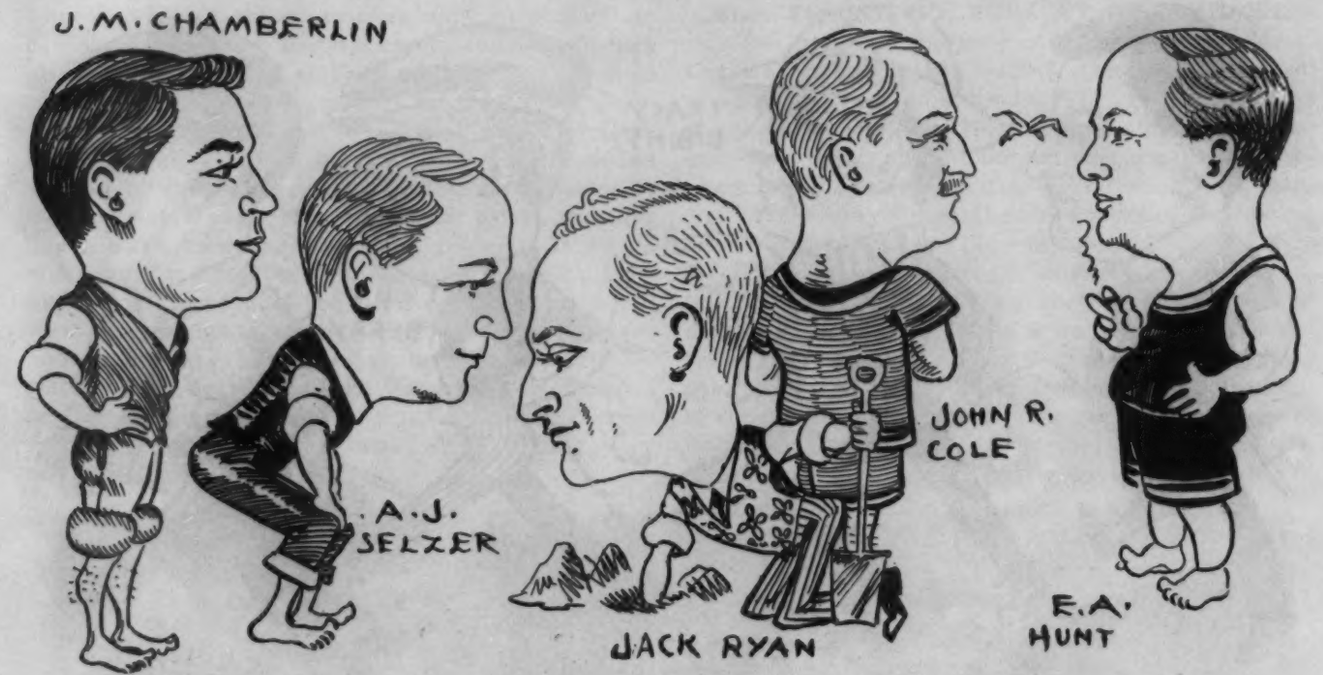
publishing the conditions and sealing the cup, to which some of the envious ones ascribe Mr. Murray's sudden interest in the Scotch game.

The honor or having won the Contractors' cup is still undecided, as the worthy secretary made his escape with the conditions of the sealed handicap in his pocket just nine hours before the scores were announced, a certain blonde lady with whom he took an automobile ride being perhaps responsible. As Russ Holabird and Bill Goodwin were tie in having the gross score nearest to the average gross this matter has been left to the god of chance. Here's luck!

Garnett Young won the Manufacturers' cup, the lynx-eyed, close-mouthed, short-eared, long-nosed committee having taken the precaution to handicap Sanderson so severely that even Col. Bogie would have had to go some.

Jobbers' Tournament, September 20, 1913.

	Net Scores.			
	Gross Score.	Patton Cup.	Jobbers and Hotel Gearhart.	Ever Ready
W. S. Berry	101	106	114	160
T. E. Burger	101	101	100	101
H. D. Brainard	93	100	98	98
H. V. Carter	109	114	115	114
C. C. Hillis	100	107	108	107
R. D. Holabird	102	109	117	109
W. L. Goodwin	102	107	115	107
E. W. Rockafellow	97	102	103	102
F. N. Killam	121	103	103	102
C. B. Hall	123	113	115	113



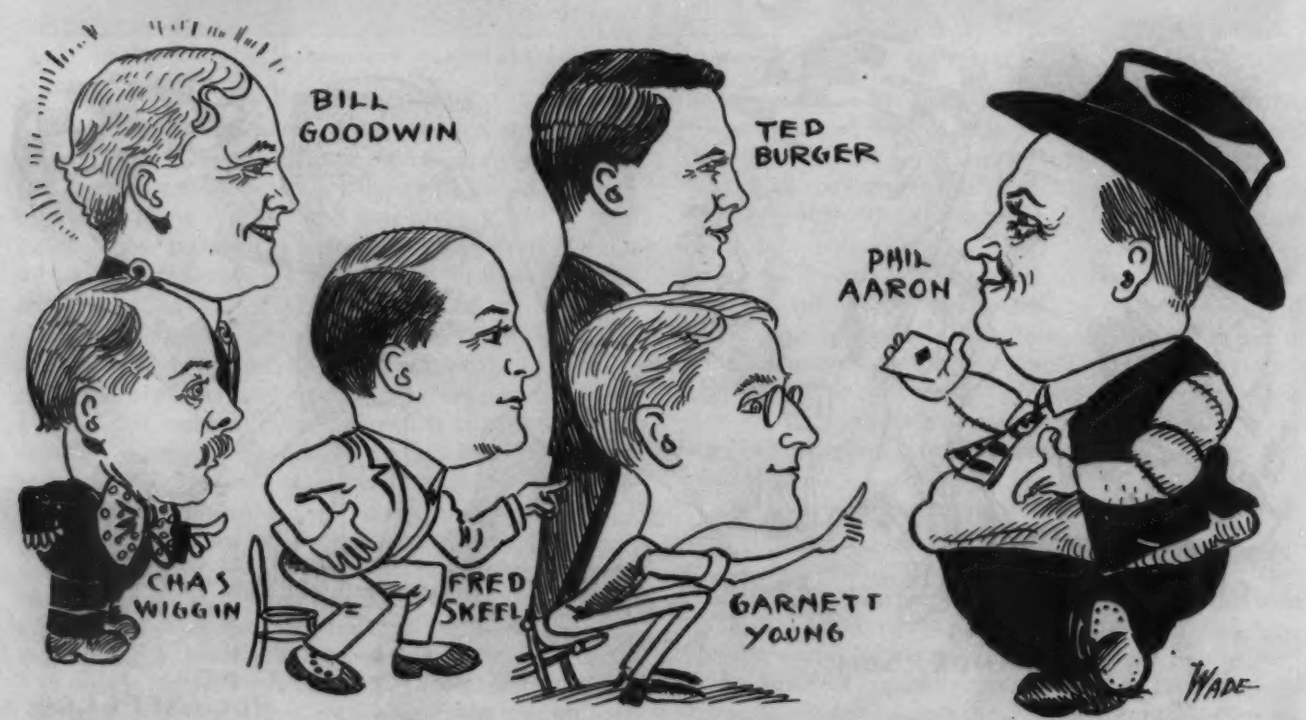
The title of champion clam-digger belongs without question of doubt to Jack Ryan. John Cole won the pool tournament while Ted Burger excelled as a seal. Nothing need be said of the magnificent showing in the water polo and the sea-water tug-of-war. Space also compels us to leave to the imagination of our readers, the glorious fires of drift-wood on the beach, the clandestine razor clam-bake and other escapades about which some of the participants are still dreaming.

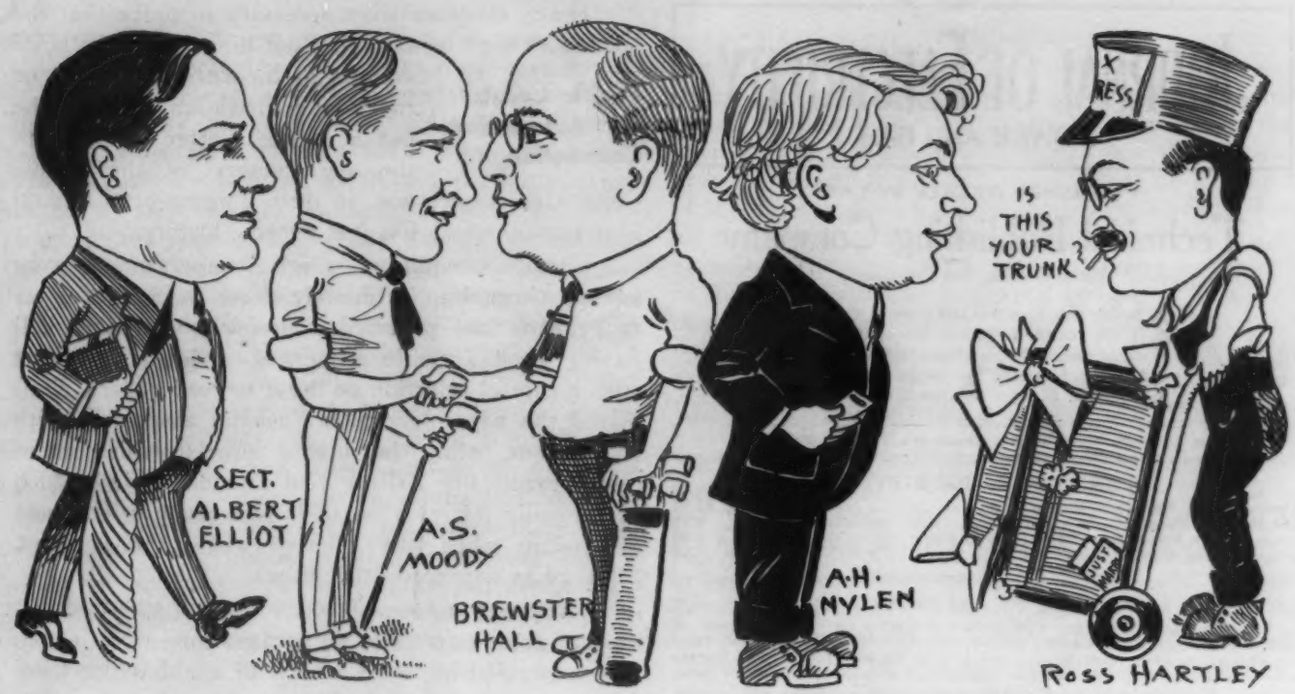
The convention came to a fitting close with the usual golf dinner on Saturday night with Col. H. V. Carter at the post of honor. On Sunday morning the party returned to Portland, where they enjoyed the hospitality of the local electrical men before returning to their usual strenuous work.

Manufacturers' Handicap for Tournament, September 19, 1913.

Based on 100.

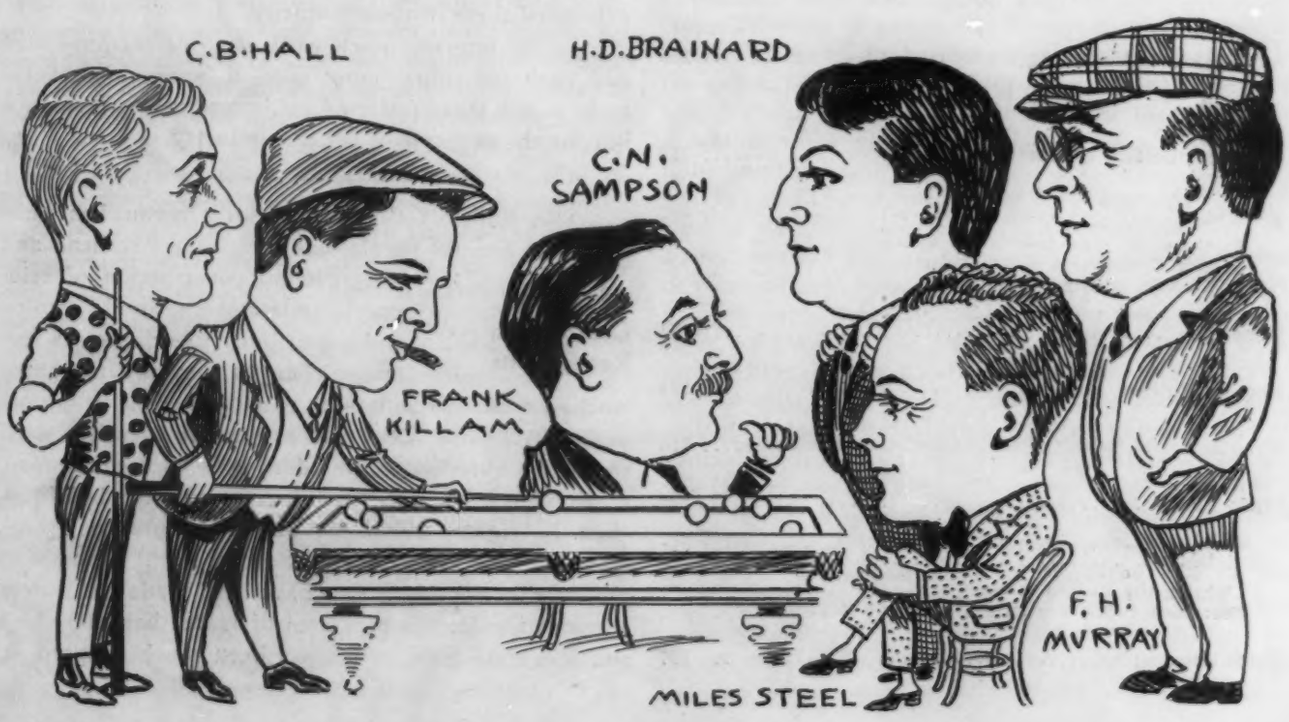
	Gross.	Hdp.	Net.
Barlow	113	—18	95
Bibbins	98	+ 4	102
Cole	114	—18	96
Gregory	108	— 1	107
Hall, W. B.	113	—18	95
Hunt	120	—18	102
Murray	168	—24	144
Moody	108	0	108
Sanderson	88	+15	103
Skeel	100	—10	90
Steel	118	—18	100
Fearing	128	—18	110
Young	92	— 4	88





The following were guilty:

Mr. and Mrs. A. E. Barlow—American Ever Ready Company, San Francisco.
Mr. and Mrs. W. S. Berry—Western Electric Company, San Francisco.
Mr. and Mrs. W. L. Goodwin—Pacific States Electric Company, San Francisco.
Mr. and Mrs. Ross Hartley—Pacific States Electric Company, Portland.
Mr. and Mrs. A. H. Nylen—Gilson Electric Company, Oakland.
Mr. and Mrs. E. W. Rockafellow—Western Electric Company, New York
P. J. Aaron—Fobes Supply Company, Seattle, Wash.
T. E. Bibbins—General Electric Company, San Francisco.
H. D. Brainard—Western Electric Company, Seattle.
T. E. Burger—Western Electric Company, Los Angeles.
H. V. Carter—Pacific States Electric Company, San Francisco.
J. M. Chamberlin—Fobes Supply Company, Portland.
John R. Cole—Harvey Hubbell Company, San Francisco.
Albert H. Elliot—Secretary, San Francisco.
D. F. Fearing—National Carbon Company, Cleveland.
S. B. Gregory—Arrow Electric Company, San Francisco.
C. B. Hall—Illinois Electric Company, Los Angeles.
H. B. Hall—Pass & Seymour, San Francisco.
A. H. Halloran—Journal of Electricity, Power and Gas, San Francisco.
C. C. Hillis—Electric Appliance Company, San Francisco.
E. A. Hunt—General Electric Company, San Francisco.
R. D. Holabird—Holabird Reynolds Company, San Francisco.
F. M. Killam—Pacific States Electric Company, Seattle.
A. S. Moody—General Electric Company, Portland.
F. H. Murray—National Carbon Company, Los Angeles.
J. F. Ryan—Western Electric Company, Portland.
H. E. Sanderson—Bryant Electric Company, San Francisco.
C. N. Sampson—American Steel Products Company, Portland.
A. J. Selzer—Adams-Bagnell Company, Chicago.
F. F. Skeel—Crouse-Hinds Company, Chicago.
Miles F. Steel—Benjamin Electric Company, San Francisco.
C. E. Wiggin—Dunham, Carrigan & Hayden, San Francisco.
Garnett Young—Telephone Electric Equipment Company, San Francisco.



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Pacific Coast Gas Association Convention

If any evidence were necessary to prove that the success of a convention does not hinge upon the large volume of business transacted or the total registration, it would be but a simple matter to point to the performance of the Pacific Coast Gas Association at their Twenty-first Annual Convention, which has just become history.

Climatic conditions, high temperatures, were against them, but fortunately those in charge of arrangements had provided a properly ventilated hall having good acoustic properties, and this, together with a careful selection of those to read papers, eliminated the soporific element usually associated with conventions, while the intense interest which maintained practically 100 per cent attendance and which occasionally left men on their feet eager to continue discussion when the allotted time had expired, achieved an unprecedented success.

The papers presented were of a high standard, yet were of great interest to all because they were invariably expressed in terms which all could understand The discussions were not of disagreement, but of corroboration. Hearty good-fellowship prevailed all round and the willingness of representatives of manufacturers to co-operate was everywhere evident.

One man with understanding may perform more than myriads ignorant, a small organization imbued with enthusiasm and properly guided may outstrip the larger organizations in excellent performance, and quality was ever better than quantity; live men better than dead ones.

The convention has passed and left many good ideas to ponder over. The Pacific Coast Gas Association meets again in convention in 1914 at Long Beach, Cal., these ideas will grow and perhaps be expressed there in their maturity.

In the interim, much work is to be accomplished and each individual must take up again his several tasks which stand not only for immediate performance but for the progress of the gas industry.

Oregon Commission Regulations

The Railroad Commission of Oregon has published its general regulations governing overhead and underground construction of telegraph, telephone, signal, trolley and power lines. Aside from a few minor changes they are the same as the tentative regulations as published in this journal on August 9, 1913, and are nearly identical with those of California. One addition is the requirement that underground tubes or conduits entering buildings shall be tightly closed at outlets to prevent gases from entering the building. Several slight changes in the clearance specifications have been made and a new specification for "power lines of more than 600 volts and less than 5000 volts" has been much adopted as

regards minimum size of wire for crossing, though this same distinction is not held as regards clearance.

This order exhibits a characteristic feature of a great majority of commission rulings, an evident spirit of fair play. It has been promulgated only after conference with all interested parties and embodies the best thought available on the subject. Contrary to the popular idea public service commissions have powers which far transcend the mere fixing of rates, and these bodies should be instrumental in improving the service and enhancing the safety of all utilities over which they have jurisdiction.

A Western Utility Association

Grave problems confront the managers of Pacific Coast public utilities. While to a large extent each man must work out his own solution, certain common factors may be applied to reduce these problems to simpler terms. But to discover these points in common it is necessary to get together frequently. With the present multiplicity of organizations we hesitate to suggest another, but the need warrants the formation of a Pacific Coast public utility association.

The fact that Western conditions are different from Eastern, while difficult for our Eastern friends to understand, is borne out by experience. High head water plants, long distance transmission lines or fuel oil cannot be successfully applied by engineers who do not understand the conditions peculiar to each locality. Witness the recent failure of a dam and destruction of a power plant constructed under the direction of the engineer for an Eastern financial house, the advice of experienced local engineers to the contrary, notwithstanding!

Nor are engineering conditions all that are different. Business methods in the West are as unlike those in the East as are the habits of the two peoples. Why attempt a house-wiring campaign in a community where ninety-eight per cent of the houses are already wired? What success would the average central station solicitor have in inducing a farmer to irrigate his crops by means of electric pumping? How much reliance will a lumberman or a mining superintendent place in the statements of a man who attempts to electrify these industries by correspondence from an office in New York City? Yet men on the ground have already made the per capita consumption of electricity in Western states exceed that in any of the Eastern.

The creation of a market for surplus electric power is a subject now engaging the attention of many of the larger electric companies. Population has not kept pace with power development and new industrial uses are being investigated as possible consumers of available power. Several of the companies have gone to considerable expense in sending representatives to study the conditions of various foreign industries with the thought of their adaptation to local conditions. Such work could be better accomplished by an association and the results given to all members. For example, selling off-peak current for the utilization of atmospheric nitrogen has long been the dream of the power man. When it is considered that nitrogen is one of the most abundant and yet one of the most expensive elements when put into saleable combinations, the possibilities of its effect on the electrical business are incalculable. Nitrogen has the singular property of being a most inert element as a diluent of the air, but a most active component of explosives or the poisonous alkaloids. Though there are about twenty tons of atmospheric nitrogen over every square mile of the earth's surface, until recently it has been directly used only by a few plants. Here it is that the puny strength of the tiny microbe is more powerful than the mighty force of lightning in causing combination. Several methods of electrical fixation have been successfully applied in Europe, but present rates on the Pacific Coast are not yet low enough to attract this industry.

Public policies also differ. The present trend of public sentiment in the West is toward municipal ownership. Where its manifest advantages can be combined with those of private operation there is a strong likelihood that many corporate organizations will become operators of systems leased from municipalities. A publicity campaign is necessary to educate the people, literally "to lead their minds into proper channels," both as regards political operation of public utilities and as concerns ill-advised competition in communities which are already adequately served. This should be directed by those in touch with the local situation in order that it may be truly effective.

Finally there is need of concerted action and a fixed policy regarding relations with employes. Where operators of public utilities are responsible to the public for a safe and efficient service, they should have full discretion in passing upon the competency of the men performing their work and of the conditions under which the work is done. Such action should be in direct accord with the beneficent principles of trade unionism but should in no way allow interference with the conduct of a business upon which the public is so vitally dependent for its utilities. This question can be satisfactorily handled only through a central office where the policy is judiciously determined and put into execution.

While all these various matters are broadly treated by the national associations, an annual meeting in some far-away city is no place to discuss problems of local interest. Some intimate, unified Pacific Coast association is necessary to handle the peculiar conditions existing in this territory. Whether this be a strong branch of a national body with local officers, as has been done by the Pacific Coast Electric Railway Association, or whether it be an independent organization, is immaterial. The great need is for action, and that at once.

Clear-eyed men of vision see a great empire from the "Rockies to the Coast" which will come into its own with the completion of the Panama Canal. Present problems will then be intensified and it consequently behooves the men whose duty it will be to supply the public utilities to this great population to get together now and prepare for the future.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

K. G. Dunn, of Hunt, Mirk & Company, San Francisco, is in Southern California on a business trip.

L. F. Yandall, Electrical Machinery & Equipment Company, Stockton, Cal., was at San Francisco this week.

George S. Nickerson, civil and hydraulic engineer of Sacramento, was at San Francisco during the past week.

W. S. Post, engineer for the Cuyumaca Water Company of San Diego, was a recent visitor in San Francisco.

H. N. Lauritzen, Pacific Coast manager for the Holophane Works of the General Electric Company, is at Los Angeles.

Frank B. Rae of New York, formerly publisher of Electrical Merchandising, paid a short visit to San Francisco last week.

T. E. Blake, manager of Hawaiian Electric Company, Honolulu, recently spent a few days at San Francisco, on his way East.

F. E. Blake, manager of the Hawaiian Electric Company, is spending a week in San Francisco, while on a vacation trip to the East.

F. F. Skeel, western manager for the Crouse-Hinds Company, is visiting the Pacific Coast, being expected in San Francisco during the next week.

E. M. Cutting returned this week from Sacramento, where he has been conducting a display at the State Fair for the Edison Storage Battery Supply Company.

John A. Britton, president of the Pacific Gas & Electric Company, of San Francisco, left for Washington, D. C., and an extended trip East the first part of the week.

H. C. Goldrick, Pacific Coast sales manager, Kellogg Switchboard & Supply Company, is in the Northwest on a business trip and will return to San Francisco next week.

C. B. Babcock, Paul Hough, R. J. Thompson, B. M. Pederson and **H. P. Pitts** were appointed a committee on Gas Exhibits at the San Jose convention to look after the novelty part of the association's work in the future.

L. Gaertner recently resigned as manager of the San Francisco branch of the Interstate Electrical Novelty Company to engage in business for himself as secretary of the Beacon Miniature Electric Company of New York.

Roger Kemp, manager of Montana Electric Supply Company at Butte, Montana, died Sept. 17th. Mr. Kemp was one of the most popular electrical men in Montana. His death has come as a severe shock to his many friends in the West.

O. C. Merrill, chief engineer of the U. S. Forest Service, whose headquarters are in Washington, D. C., has just returned to Washington from San Francisco via Portland. While in California Mr. Merrill made several filed trips accompanied by District Engineer Fowler.

H. V. Carter, president of the Pacific States Electric Company, San Francisco, has extended his visit to the recent Jobbers' Convention at Portland, to Seattle and the Northwest and contemplates spending a several days' trip in that region.

C. B. Hawley, president and general manager of the Intermountain Electric Company, Salt Lake City, has returned from an extended trip to the East where he attended the convention of the National Electrical Contractors. Mr. Hawley was accompanied by his family, and combined much sightseeing with his business.

J. E. McDonald, secretary Joint Pole Committee, Los Angeles, **Royal W. Sorensen**, Professor of Electrical Engineering, Throop Polytechnic Institute, Pasadena, Cal., and **Victor A. Dorszeski**, electrical engineer Portland, have been transferred to the grade of member in the American Institute of Electrical Engineers.

Carl D. Schluederberg, manager of the switchboard sales department of the Westinghouse Electric & Manufacturing Company, is spending a few days at Salt Lake City getting in touch with the local conditions. This is is Mr. Schluederberg's first trip west of Chicago, and he is very favorably impressed with the rapid strides which have been made in electrical development in the West during the past few years.

S. R. Inch, general superintendent of the Utah Power & Light Company, and **G. B. Thomas**, auditor for the company, have returned from Boise, Idaho, where they went with **P. B. Sawyer**, general manager, on a business trip. Speaking of conditions as he found them in Idaho, Mr. Inch reports: "Generally things seem to be in good shape. Everybody talks about big crops and good business. Our company has nothing at Boise, but the companies operating there report considerable activity. Boise is prosperous and the city looks fine. Along the line the little towns also appear to be in a flourishing condition. Of course there is little between Pocatello and Nampa but sagebrush and desert, but even that seems to be a country of great future opportunities. This side of Pocatello agricultural conditions are promising."

R. R. Tour, the new instructor in Gas Engineering at the University of California, graduated from the University of Michigan in 1910, getting the degree of B. S. in Chemical Engineering. During the following year he held the Fellowship in Gas Engineering, given by the Michigan Gas Association. After serving for a time as the superintendent's assistant in the employ of the Consolidated Gas Company of New York, he was made assistant superintendent of the plant at Astoria, L. I., which position he resigned to accept his present one. This position was created by the Pacific Coast Gas Association, the course in gas engineering having been started the first of the year by Prof. Sibley and supplemented by lectures from John A. Britton and E. C. Jones. The new course opened with eighteen students and bids fair to become a leading factor in the Mechanics Department.

Harry J. Billica, Washington Water Power Company, Spokane, **Louis N. Brodens**, electrical engineer, E. H. Heaps & Company, Vancouver, B. C., **Thomas Burns**, construction electrical engineer, Prince Rupert Hydroelectric Company, Ltd., Prince Rupert, B. C., **T. F. Copeland Jr.**, electrical engineer, Pacific Gas & Electric Company, San Francisco, **C. H. Fletcher**, city electrician, Vancouver, B. C., **W. H. Fribley**, superintendent of construction, Raymond, Wash., **J. I. Kohn**, draftsman, Pacific Gas & Electric Company, San Francisco, **R. P. Lutzi**, electrical engineer, Pacific Gas & Electric Company, San Francisco, **R. L. Martin**, electrical engineer, Western States Gas & Electric Company, Richmond, Cal., **K. H. R. McGuinn**, engineer of underground construction, Western Canada Power Company, Ltd., Vancouver, B. C., **L. N. Peart**, general superintendent, San Joaquin Light & Power Corporation, Fresno, Cal., **L. F. Rawden**, municipal electrician, South Vancouver, B. C., **E. N. Ridley**, telephone salesman, Northern Electrical & Manufacturing Company, Vancouver, B. C., **Eric Therkelsen**, engineering instructor, University of Washington, Seattle, **W. L. Wales**, chief engineer Yolo County Consolidated Water Company, Woodland, Cal., and **Frank G. Whitney**, wire chief, Pacific Telephone & Telegraph Company, Los Angeles, have been elected associates in the American Institute of Electrical Engineers.

MEETING NOTICES.

Jovian Electrical League of Southern California.

Mayor H. H. Rose addressed the Jovian Electrical League of Southern California at their regular meeting Wednesday, September 24th, at Christophers.

Electrical Development and Jovian League.

Tuesday, Sept. 23, was Jovian day and under the able leadership of Alternate Statesman W. W. Hanscom a pleasant

hour was spent with moving pictures and moving stories at Tait's cafe. The prize for the best story was awarded to Tom Collins and for the best song to Ralph Phelps.

Oregon Society Engineers.

The following committee of the Oregon Society of Engineers has been appointed to investigate the need for a "Joint Pole Committee" in Portland. They will also recommend to the Society, the best means of establishing a commission in Portland. Following is the personnel: R. Z. Young, B. C. Condit, H. A. Kirkland, O. B. Coldwell, and F. D. Weber.

Los Angeles A. I. E. E.

The Los Angeles Section of the American Institute of Electrical Engineers celebrated the opening of the fall season on September 25th with a reception and dinner to Ralph W. Pope, honorary secretary and F. L. Hutchinson, secretary A. I. E. E., at the Union League Club, Second and Hill streets. A report of the Pacific Coast Meeting at Vancouver, B. C., was made and an enjoyable evening spent.

San Francisco Section A. I. E. E.

The first meeting of the San Francisco Section for the season of 1913, was held Friday, September 26, 1913, at 8 p.m., in Native Sons Hall. Mr. W. L. R. Emmett of the General Electric Company, addressed the Section on the subject, "Electric Propulsion of the U. S. Collier 'Jupiter,'" which was thoroughly enjoyed by all present. This vessel was recently tested and made a creditable showing. More thorough tests will be made later. The results are being watched with much interest.

Street Railway Employes' Convention.

The convention of the Amalgamated Association of Street Railway Employes of America adjourned on the 17th inst., and in spite of the strenuous efforts of C. O. Pratt to have the Philadelphia local reinstated, adjournment was held without taking favorable action on their petition. The controversy took a new turn the day following the adjournment of the convention when Mr. Pratt succeeded in having a writ of mandate served on the officers of the association requiring their presence before Judge M. L. Ritchie in the district court to show cause why Pratt and his Philadelphia associates should not be reinstated.

Utah Society of Engineers.

The first fall meeting of the Utah Society of Engineers of Salt Lake City was held in the Stock Exchange Building on the 20th inst. Mr. A. H. Thiessen, section director of the United States weather bureau, delivered the first paper of the evening dealing with atmospheric conditions and their effect on the smoke nuisance. O. W. Ott, consulting engineer, read an extensive and interesting paper on the smoke nuisance explaining the causes and methods of minimizing the smoke generated by combustion. Professor E. H. Beckstrand of the University of Utah, submitted statistics indicating that about forty tons of soot are spread over the city daily during the winter months as a result of the improper firing of furnaces. George H. Dern, chairman of the Commercial Club special committee, Dr. Samuel G. Paul, health commissioner, W. H. Bywater, chief of the fire department, and Mr. Drake of the National Association of Stationary Engineers, joined in the discussion which followed the reading of the papers.

TRADE NOTES.

The Ohio Brass Company announces that it is now in position to furnish with pin driven terminals all forms of its all-wire bonds which were previously furnished with compressed terminals.

The Seattle office of the General Electric Company has sold a 1000 kw. turbine generator with switchboards and Wheeler surface condenser to the Alaska Treadwell Gold Mining Company of Juneau, Alaska.

Pierson, Roeding & Co., San Francisco, announce the change of location of the business office of the Safety Insulated Wire & Cable Company from 589 Howard street to 118 New Montgomery street, the headquarters of the former concern.

The Holtzer-Cabot Electric Company has just issued an interesting pamphlet devoted to electric fire alarm systems for schools. The booklet contains illustrations of several types of apparatus, also wiring diagrams for typical installations.

NePage, McKenny & Company have been awarded the contract for complete electrical installations in the eight story Pittock Block being erected for the Northwestern Light & Power Company. The contract amounts to approximately $16,000.

"Motor Drive in the Silk Industry," "Selecting Motor Equipment for Electrically Operated Hoists," "Motors for Intertype and Linotype Machines," and "Alternating-Current Magnet Switches" are the titles of pamphlets and leaflets recently issued by Westinghouse Electric & Manufacturing Company.

The general Gas Light Company, Kalamazoo, Mich, is distributing a neat folder, The Guide by Night, devoted to Humphrey Gas Arc Lamps. This company has also recently issued a supplementary data sheet showing plan, elevation, and test data on an installation of these arcs in a wholesale millinery goods show room.

MANUFACTURERS' EXHIBIT, PACIFIC COAST GAS ASSOCIATION CONVENTION.

One of the contributing factors to the great success of the convention was the manufacturers' exhibit on the ground floor of the convention building, which merited all the interest shown by both the public and the visiting delegates. The representatives of the manufacturers spared no effort in making the displays at once unique, comparatively complete, novel and attractive.

The Pacific Gas and Electric Company used the daily papers as a means of inducing the public to attend the exhibits, and added to the interest by giving a magnificent gas range to the visitor holding the lucky number.

The Welsbach Company showed a new line of units using the Reflex 20, a burner designed to compete with high power Mazda lamps; a new semi-indirect unit of artistic and attractive lines, and the Ives Daylight Producer, a new incandescent gas mantle color matching lamp of marked merit.

The General Gas Light Company showed a complete line of gas arcs both for interior and exterior installation; also street light standards installed alongside the regulation electric light standard for comparison.

The Clark Stove Manufacturing Company, Walker Stove and Range Company, W. F. Boardman Company, and the Trenkamp Stove Company each exhibited a nice line of stoves, some having novel features.

Rector System Gas Heating Company, San Francisco, Cal., had a working exhibit of their gas radiators. This system seems to be increasing in popularity on account of its many excellent features, such as ease of control and so on.

An exhibit of pipe fittings and other similar lines was displayed by the H. Mueller Manufacturing Company. The Ruud system of water heating was also shown.

Last but by no means least was the exhibit of the Davis Meter Company of San Diego, Cal., showing the construction of their gas meters.

A continual round of demonstration and a large number of photographs showing the many new applications of gas for industrial fuel aided in rounding out the success of the manufacturers' effort.

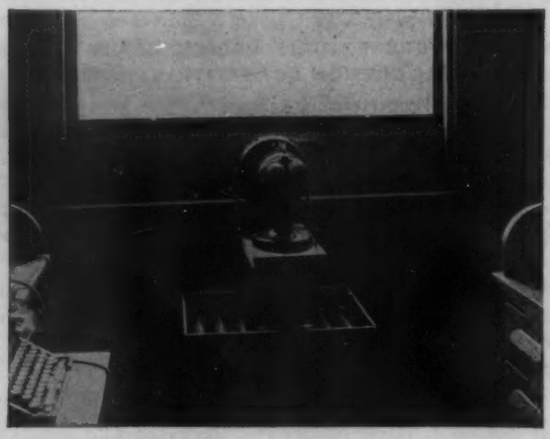
INDUSTRIAL

NECESSARY OFFICE VENTILATION AT SMALL EXPENSE

Every grown person needs 3600 cubic feet of fresh air every hour! Without this amount of pure air, any man or woman labors under an unnecessary burden that lowers the vitality and reduces the efficiency for accuracy work by an amount proportional to the decrease in the air supply.

Take the case of an office 14 by 20 ft. and 11 ft. high, which contains about 3080 cubic feet of air. To supply each of four occupants with 3600 cubic feet of fresh air per hour, the air must be completely renewed about six times per hour or a little oftener than once every ten minutes. It is evident that it would take a pretty stiff draft blowing through a 5 ft. window raised 3 inches to secure this ventilation. In the winter, coat collars would be turned up, fur collars put on, and there would be four pairs of cold feet. But ventilation can be secured without cooling the room.

If a small motor-driven blower is arranged with a few short pieces of piping so that fresh air is drawn from the outside and delivered against a steam radiator, the air will be warmed and delivered in a gentle current which will not cause any one to be uncomfortable and yet the room will be warm and the air fresh.



Office Ventilating Set.

Such an arrangement is shown in the illustration, where a Westinghouse motor driving a Sirocco blower is mounted on a stand directly over a steam radiator. The intake of the blower is piped with a gate between it and the board set in the window to give access to the outside air; the outlet delivers the air at the top of the radiator. The air is prevented from blowing along the floor by a galvanized iron box which surrounds the radiator on all four sides, extending from the floor to the top of the radiator but open at the top. Thus the cold air is delivered at the top of the radiator in a downward current, and before it can find its way out of the box again, it must rise around the radiator and become warmed. The blower shown is capable of supplying 175 cubic feet of air per minute, or 10,500 cubic feet per hour, a sufficient supply for three persons. The natural ventilation provided through the opening of doors, around the edges of the windows, and in other ways is sufficient for an additional person.

It should be remembered that the action of the blower will be to stimulate the action of the radiator; the cold air cools the radiator, condenses the steam and causes fresh steam to enter; thus increasing the circulation of steam and causing the radiator to give out more heat.

LIGHTING THE MODERN CIRCUS.

One of the latest provinces wherein electricity furnishes light at night is under the big canvases of the great modern circus, a veritable city that is always on the move and must therefore be completely self-contained and portable. Open flame gasoline torches or gas lamps have lighted circuses for many years; but this season two of the largest tent shows in the world, Barnum & Bailey and Ringling Bros., are equipped with their own power plants for lighting the big top and smaller tents by electricity.

The apparatus consists of 25 kw. portable gasolene-electric sets manufactured by the General Electric Company specially for the purpose. The units are carried in duplicate, two sets for each circus, so that if one should, by any chance, become disabled while enroute, the other can supply current for half the lights. They are arranged, however, to operate regularly in multiple, each set furnishing current for eighteen arc lamps, which totals thirty-six of these lamps for lighting a show. Two 25 ampere spot lights for the stage and several strings of incandescent lamps are also operated from the plants in each instance. A third supply wagon used for a workshop accompanies the outfits and has a powerful electric searchlight mounted on top, which is directed to different parts of the grounds while taking down tents and loading after the evening performance.

The outfits are compactly built and are readily portable. They are mounted on one of the ordinary enclosed circus wagons, about 18 ft. long and 7 ft. wide, with the ends and sides of the truck body removable. Each unit is composed of a 25 kw., 125 volt, compound wound, direct current generator, which is built integral with the frame and direct connected to the shaft of a four-cylinder, four-stroke cycle, 560 r.p.m., throttle-governed, vertical gasoline engine.

The set is installed on the rear of the wagon with the flywheel at the outer end. The switchboard for controlling the current is located about two feet from the generator end of the unit. This is of the slate panel type with main and feeder switches, instruments, rheostats, etc. At the front of the truck is installed the cooling system for the engine. It consists of a pressed steel radiator having a 320-foot radiating surface, which is cooled by two motor-driven fans. A 65-gallon, cylindrically shaped water tank is mounted directly over the radiator. The gasolene supply tank, holding twenty gallons, and engine muffler are suspended underneath the wagon. The tents are all equipped with protected wiring that can be easily and quickly installed and removed each time the tents are erected and taken down.

Ignition is effected by a low-tension, automobile type magneto and induction coil, with an auxiliary battery for starting. The governor is very sensitive and responds instantly to changes in load. It limits the speed variation of the engine from no load to full load within 4 per cent, which with the type of generator employed insures constant voltage. Adequate lubrication is secured by forced circulation from an oil pump.

The generator is one of the latest multipolar continuous current machines, designed especially to meet the characteristics of the engine to which it is connected. The field winding is compounded and compensates for the drop in engine speed between no load and full load, thereby maintaining a constant voltage throughout the entire range of operation. All similar parts of these outfits are built so that they are readily interchangeable in so far as is mechanically practicable, which allows replacing with renewals without tedious fitting.

NEWS NOTES

INCORPORATIONS.

BOISE, IDAHO.—Articles of incorporation have been filed for the Adams County Light & Power Company of New Meadows, capitalized at $200,000. This is the same company that has asked the public utilities commission for a permit to give electric service to Meadows, New Meadows, Council, Cambridge and other towns. The incorporators are: B. Gastad, N. Gastad, W. H. Hall, Eugene Enloe and W. N. Scales.

ILLUMINATION.

BREMERTON, WASH.—The voters of Bremerton last week voted against the municipal light plant.

ALBANY, ORE.—C. L. Rauch and associates of Albany will request a new gas franchise from the city.

BAKER CITY, ORE.—The city council has passed an ordinance ordering the sale of the $25,000 bonds for the new municipal light plant. Steps to insure the actual construction of the plant will be taken as soon as possible.

SAN BERNARDINO, CAL.—Mayor J. W. Catick has announced plans for municipal improvement, which will include bond issue of about $300,000. It is proposed that the city acquire the electric light plant, and electric street railway.

GLENDORA, CAL.—Bids will be received in about 60 days for installing a lighting system for this city, consisting of 210 ornamental lighting posts and several miles of conduits, together with junction boxes, conduit boxes and time switch controls.

SAN FRANCISCO, CAL.—The Pacific Gas & Electric Company has been instructed to light and maintain electroliers on Polk street, between Sutter and Pacific avenue and on Mason street between Post and Turk streets and to remove the gas lamps at those locations.

PALO ALTO, CAL.—District Attorney Swart has approved the petition asking for the establishment of a highway lighting district comprising the Denniston voting precinct and it has been ordered that an election be called to permit the citizens to vote on the question.

GALLUP, N. M.—A resolution has been adopted by this city calling a special election to be held on October 7th, for the purpose of submitting to the voters the franchise applied for by the Peoples Light & Power Company to construct and operate an electric light plant within the corporate limits of Gallup.

LOS ANGELES, CAL.—The Board of Public Works and Acting Mayor Whiffon at a conference with the city auditor completed arrangements whereby $25,000 per month will be advanced for three months out of the general fund for completing the aqueduct power house and getting about $1,000,000 worth of electrical machinery hauled before the rainy season begins.

PASADENA, CAL.—Resolutions have been adopted by the commissioners of the city of Pasadena declaring intention to order construction and installation of lights, posts, wires, pipes, lamps, and other necessary appliance for lighting Waverly and Bellevue Drives between Pasadena and Orange Grove avenues, in accordance with plans and specifications and resolution requirements.

PROVO, UTAH.—The representatives of the Utah Gas & Power Company, who are installing a gas plant in this city, appeared before the city commissioners and asked that action be deferred until November first on the signing of contracts for Provo's proposed Great White Way. The company represented that by that date it would have its plant in shape to enter the field for supplying the required light.

SOUTH VANCOUVER, B. C.—Mr. Rawden's report to the council on municipal electric plant estimated that a thoroughly modern crude oil plant would cost $400,000. The second unit would cost $200,000. Mr. Rawden states that the plant could produce light and power by day and sell this to the consumers for two cents a kilowatt hour. At night the current could be sold for between 7 and 8 cents per kw.-hr.

SAN FRANCISCO, CAL.—The following bids were received for complete electric work on the new city auditorium: The Turner Company, $21,445; Rex Electrical Construction Company, $28,787; Decker Electric Company, $21,489; Standard Electrical Construction Company, $22,774; A. E. Brook Ridley, $22,793; Globe Electrical Works, $27,965; H. S. Tittle, $20,500; McFell Electric Company, $22,585; Newberry-Bendheim Company, $17,400; Butte Engineering & Electric Company, $22,500; Bay Counties Electric Construction Company, $43,500.

COVINA, CAL.—The following bids were received for center street ornamental lighting system. The total length of frontage is 3645.65 ft., requiring 42 posts and 7980 ft. of conduit:

Newberry, Bendheim Electric Company	$3974.00
K. T. Bennett, Los Angeles, Cal.	4455.00
Granger Hall Electric Company, Ontario, Cal.	4600.00
Woodill Hulse Electric Company	4730.81
Geo. R. Albers, Covina, Cal.	4994.00
Pacific Underground Construction Co., Las Angeles, Cal.	5092.29
John C. Jacobs, Pasadena, Cal.	5249.00
E. L. McEwan, Ocean Park, Cal.	7337.40
Estimated by F. G. Dessery	4263.00

The contract was awarded to the Newberry, Bendheim Electric Company, at $3974.00.

SAN FRANCISCO, CAL.—The state commission has instituted an investigation into the wholesale price of natural gas in Los Angeles County. The matter was brought to the attention of the commission by a resolution of the city council of Los Angeles, asking the commission to establish a price which producing and pipe line companies should be allowed to charge distributing companies for the natural gas product. Natural gas was recently introduced into Los Angeles county, carried by pipe lines from the Kern county fields. The gas is sold at wholesale outside the city limits of Los Angeles to the distributing companies, which retail it within the limits of the city. The commission's jurisdiction has arisen from the fact that the gas is sold by the producing and pipe line companies to the distributing companies at a point outside the city limits of Los Angeles. The rates within the city of Los Angeles have become a subject of controversy, and on this matter the city authorities of Los Angeles desired that a wholesale rate be first established.

TRANSMISSION.

SAN FRANCISCO, CAL.—The application of the Power & Irrigation Company of Clear Lake to the State Water Commission for a permit to appropriate the waters of Clear Lake for the generation of electricity has been denied.

BELLINGHAM, WASH.—The Sumas Electric Light Company, Sumas, Wash., has filed application with the county auditor for a franchise to construct and operate transmission lines for electric power and light, as well as for a telephone line along the county roads of Whatcom County.

MONTESANO, WASH.—The Elma Light & Power Company, Elma, Wash., has filed application for a franchise to construct and maintain a line of poles and wires to furnish electric current along the county road. October 6th has been set as the date for the hearing of this question.

SALT LAKE CITY, UTAH.—Notice has been received by the local United States Land Office of the withdrawal from settlement, location, sale or entry of approximately 2670 acres of land in Blacksmith Fork Canyon, Cache County, Utah. The land is now included in land reservation No. 393, and will be utilized as water power sites.

LOS ANGELES, CAL.—Officials of the Pacific Light & Power Corporation will appear before the State Railroad Commission to make formal application for permission to issue $52,300 in stocks and $1,730,000 in bonds.; $497,000 of the bond proceeds are to be used to refund underlying bonds, and the balance, $1,243,000 will be used in connection with the Big Creek and other hydroelectric projects of the company.

LYLE, WASH.—An important step in the final disposition of the water power question was made here in the transfer of all the Ham, Yearsley and Ryrie interests on the Klickitat River to Edgar A. Torrance, a representative of the Northern Pacific Railway Company. A clause in the transfer prevents the construction of a dam at the point where such work was originally begun by the Northwestern Electric Company before their withdrawal from the field was forced.

ELY, NEVADA.—Preparations are being made on Illipah Creek about 30 miles west of Ely for the erection of a power plant to supply Hamilton and the White Pine mining district with electric current for power and lighting purposes by the Hamilton Power, Mining & Transportation Company, which is controlled by residents of McGill. Surveys and calculations made by the company engineers show that 340 h.p. can be generated on Illipah Creek aboout 6½ miles from Hamilton. The plant will cost more than $30,000. Construction will be started shortly.

SAN FRANCISCO, CAL.—The Oro Electric Corporation has appealed to the supreme court of California from the decision of the railroad commission refusing it permission to enter Stockton. The chief ground of the appeal is that the municipality of Stockton granted the company a franchise to carry on its business there. The contention is made that cities like Stockton have the right to choose whether or not they desire competition, and, having decided that they do, that it does not lie within the power of the commission to deny the company entrance to the city.

LOS ANGELES, CAL.—Suit has been filed in the United States court by George J. Henry Jr., against the city of Los Angeles for infringement of patent. The complainant alleges that the city has infringed and is infringing this patent at present. The infringement consists in the use of certain apparatus for developing power on the line of the Los Angeles aqueduct and the matter is believed to be of extreme importance because of the prospects of development of power in the future upon a large scale, by converting the energy of the flowing aqueduct waters into electricity. The suit was brought through Attorney Raymond Ives Blakeslee.

PORTLAND, ORE.—Co-operation between the state governments of Oregon and Washington and the War and Interior departments of the federal government will be sought by the committee created by the Oregon Legislature to determine the feasibility of, and to outline plans for, the construction of a publicly-owned hydroelectric power project on the Columbia River near the Big Eddy rapids. The commission met informally this week with Vernon A. Forbes of Bend and J. D. Abbott of Portland, members of the lower house of the legislature; I. N. Day of Portland, state senator, and John H. Lewis, state engineer, present. On account of the absence of Senator J. C. Smith of Grants Pass the fifth member, the committee did not organize.

TRANSPORTATION.

SAN FRANCISCO, CAL.—The supervisors at their last meeting adopted a resolution, recommended by the Lands and Tunnels Committee, Supervisor Mauzy, chairman, abandoning the proceedings looking toward the construction of a tunnel in Fillmore street.

OGDEN, UTAH.—The directors of the Ogden Rapid Transit Company have instructed Manager P. D. Kline to commence the work of double tracking the Washington avenue line between Twenty-eighth and Thirty-second streets. The company expects to have this work completed by the first of November.

SALT LAKE CITY, UTAH.—The Utah Light & Railway Company has surveyors in the field laying the preliminary lines for the proposed extension of their suburban line from Holiday to Big Cottonwood Canyon along the county road. This canyon boasts as fine scenery as any in the Wasatch range.

SEATTLE, WASH.—Bids will be received by W. D. Freeman, purchasing agent of the city of Seattle, until October 1, for supplying cross arms, braces, insulators, and other material for feeder and trolley construction, exclusive of conducting wire, for the Seatlle Municipal Street Railway, in accordance with plans and specifications approved by the board of public works.

PORTLAND, ORE.—S. S. Bullis of New York has secured a heavy interest in the well-known Standard mine of Jackson County, Ore., and is installing a 450 k.v.a., 6600 volt, 3-phase, 60 cycle Bullock generator to be direct connected to a Worthington turbine, for mine purposes, also to supply electric energy for a Medford trolley system. It is the intention to extend this to an interurban system linking up the towns of Medford, Ashland, and Jacksonville. Street excavation in Medford for track laying is under way.

HANFORD, CAL.—F. S. Granger, the promoter of the Fresno, Hanford & Summit Lake Railroad, has severed his connection with the company and has disposed of his interest in the interurban line to John S. Somers, an Oakland broker, who purchased the stock for L. H. Jones, a civil engineer and his associates. Granger, having sold his stock, steps out as president, manager and director of the road and is succeeded as director by Somers and as manager by Jones. A. B. Clark, the vice-president, will act as temporary president until the company is reorganized.

TELEPHONE AND TELEGRAPH.

REEDLEY, CAL.—In order to provide more suitable quarters in which to house its central office, apparatus, the Reedley Telephone Company has made arrangements to lease a new building about to be erected for it on Eleventh street, between F and G.

GLENDIVE, MONT.—C. A. Rasmussen of the executive committee of the Pioneer Telephone Company, awarded the contract to Frank O'Malley for the construction work on 63 miles of the proposed line, the first unit of the company's projected line to Jordan.

PORTLAND, ORE.—Expenditures aggregating approximately $150,000 have been authorized by the Pacific Telephone & Telegraph Company to provide for increased business in Portland and immediate vicinity. Included in the work thus provided for are new poles and cable lines in Portland Heights and vicinity, long distance lines between Portland, Aurora and Salem and a new conduit in Montavilla.